MONTHLY WEATHER REVIEW.

Editor: Prof. Cleveland Abbe. Assistant Editor: Cleveland Abbe, jr.

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The Monthly Weather Review summarizes the current manuscript data received from about 3,500 land stations in the United States and about 1,250 ocean vessels; it also gives the general results of the study of daily weather maps based on telegrams or cablegrams from about 200 North American and 40 European, Asiatic, and oceanic stations.

The hearty interest shown by all observers and correspondents is gratefully recognized.

Acknowledgment is also made of the specific cooperation of the following chiefs of independent, local, or governmental services: R. F. Stupart, Esq., Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Señor Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt. S. I. Kimball, General Superintendent of the United States Life-Saving Service; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; Dr. W. N. Shaw, Director of the Meteorological Office, London; Maxwell Hall, Esq., Government Meteorologist, Kingston, Jamaica; Rev. L. Gangoiti, Director of the Meteorological Observatory of Belen College, Habana, Cuba; Señor Luis G. y Carbonell, Director, Meteorological Service of Cuba, Habana, Cuba; Rev. José Algué, S. J., Director of the Phillipine Weather Bureau, Manila; Maj. Gen. M. A. Rykachef, Director of the Physical Central Observatory, St. Petersburg, Russia; Carl Ryder, Director, Danish Meteorological Institute, Copenhagen, Denmark.

As far as practicable the time of the seventy-fifth meridian is used in the text of the Monthly Weather Review.

Barometric pressures, both at land stations and on ocean vessels, whether station pressures or sea-level pressures, are reduced, or assumed to be reduced, to standard gravity, as well as corrected for all instrumental peculiarities, so that they express pressure in the standard international system of measures, namely, by the height of an equivalent column of mercury at 32° Fahrenheit, under the standard force, i. e., apparent gravity at sea level and latitude 45°.

FORECASTS AND WARNINGS.

By Prof. E. B. Garriott, in charge of Forecast Division.

In the United States the opening days of June were unusually warm. In southern Texas and the valleys of California maximum readings were above 100° and at points in the middle and southern Plateau temperatures were higher than previously recorded for the same season of the year.

From the 2d to 6th a barometric disturbance that moved northeastward from the western portion of the Gulf of Mexico caused heavy rain in the Gulf and Atlantic States, and an area of low pressure that covered the Rocky Mountains was attended by showers from the Rockies over the central valleys and Great Lakes. West of the Rockies the rapid melting of a large accumulation of snow in the mountains caused freshets in streams.

The second week in June averaged cool in the Rocky Mountain and Plateau regions and thence over northern districts to the Atlantic coast, and temperature was above normal in the Southern and North Pacific States. At points in the Southwest maximum temperatures were above 100°, and in the interior valleys of California and Oregon they were above 90°.

Disturbances that advanced from the Plateau and Rocky Mountain districts to the St. Lawrence Valley from the 8th to 11th and 11th to 14th were attended by rain generally from the Rockies to the Atlantic, and on the 12th and 13th severe thunder, rain and windstorms caused damage in Virginia and North Carolina. Following the disturbance of the 11–14th minimum temperatures were near the freezing point in the mountain and Plateau districts of the West and in northern New England, and on the morning of the 15th a minimum of 30° and frost, for which warnings had been issued, occurred in the cranberry bogs of Wisconsin.

During the third week of June temperature was high over the Plains States and Northwest and low over the central valleys, Great Lakes, Middle Atlantic and the interior of the New England States.

From the 16th to 18th a disturbance advanced from the Northwest over the northern interior valleys to the Canadian Maritime Provinces attended by heavy rain in the Atlantic States and snow in eastern Ontario. This disturbance was followed by a cool wave that overspread districts east of the Rocky Mountains, and on the morning of the 19th temperatures as low as previously reported for the time of the year were noted in the upper Ohio Valley and the Middle Atlantic States, and light frost occurred at points in the Rockies, the Lake region, and in the cranberry district of New Jersey.

On June 19 the following special forecast was issued:

> Present barometric pressures indicate that as compared with the past week the week beginning Sunday, June 20, will be warmer and drier generally in the great agricultural districts east of the Rockies.

During the week covered by this forecast high barometric pressure over the Southeast and low pressure along the northern border of the country produced prevailing southerly winds, decidedly higher temperatures, and generally clear skies east of the Rocky Mountains. In the Middle Atlantic States maximum temperatures rose each day to 90°, or above, from the 20th to 28th, and at Washington, D. C., this was the longest warm spell on record for June.

The higher upper air conditions that accompanied this warm wave are indicated by Mount Weather records for the 23d and 24th, when at elevations of 7,900 and 16,700 feet, respectively, above the station temperature was 50° on the 23d, and 32° on the 24th, and the rate of decrease in temperature was 3.3° and 2.9° per 1,000 feet. On each day the wind direction aloft and at the surface was west. On the remaining five of the seven days on which upper air observations were taken the kites attained heights that varied from 2,200 feet on the 22d to 5,500 feet on the 6th, and the average rate of temperature fall for the entire period for elevations of one mile, more or less, was 3.5° per 1,000 feet. As the average rate of fall in temperature in free air is about 3° for each 1,000 feet it will be seen that during this warm period there was about an average rate of fall to the mile level and also, on days observations were obtained, to the 1½ and 3-mile levels.

In a record of a balloon ascension made June 26 from Fitchburg, Mass., Charles J. Glidden reports that at an elevation of

2,400 feet the thermometer read 60°, with a temperature of 85° at the earth's surface. The rate of fall in this case was about 10° per 1,000 feet, or more than three times the average rate.

The conclusion to be drawn from available data is that the stagnant atmospheric condition attending periods of excessive heat extends a mile, and probably two or three miles, or more, above the earth with temperature gradients about or greater than the average, and that heated periods are due to a slowing up of atmospheric movements over a large area and a gradual superheating by the sun's rays of the stagnated air mass. Observations show also, that the termination of a heated period is indicated about two days in advance by an acceleration of the upper air currents, by a sharp decrease in upper air temperatures and by an increase in the temperature gradient at elevations of 8,000 to 10,000 feet, or more, above the earth.

During a greater portion of the month high barometric pressure over high latitudes of the North Atlantic Ocean caused a flow of exceptionally cold northerly winds over the British Isles and adjacent portions of continental Europe. On the 18th pressure began to fall over Iceland and from the 20th to 25th an area of low barometer occupied the British Isles.

During the second decade of the month low pressure over Bering Sea and high pressure over the Hawaiian Islands apparently contributed to the warm period of the third decade over the United States, and a reversal of pressure distribution over the Pacific area during the third decade was followed over the United States by a change to cooler weather during the closing days of June and the early portion of July.

Based upon changes in Atlantic and Pacific pressures the following special forecast was issued Saturday, June 26:

> The warm wave that has covered the country east of the Rocky Mountains during the past week will begin to moderate Monday and the week beginning the 28th will as a whole be cooler than the preceding week.

A gradual moderation in temperature began over the eastern portion of the country on June 29 and during the early days of July temperature fell below normal over eastern and northern districts with minimum readings close to the July record in the Middle Atlantic States.

BOSTON FORECAST DISTRICT.*

[New England.]

The first half of the month was cool, and the latter half warm with excessive temperatures on several days. General rains fell on the 5–6th and 17–18th; during the balance of the month precipitation was in the form of irregularly distributed showers. No storm warnings were issued and no gales occurred on the coast.—*J. W. Smith, District Forecaster.*

NEW ORLEANS FORECAST DISTRICT.*

[Louisiana, Arkansas, Oklahoma, and Texas.]

Abnormally warm weather prevailed during the greater portion of the month, and rainfall was unevenly distributed, being deficient in some localities and in excess in others. The only storm of the month appeared off the mouth of the Rio Grande River on the 30th, and northeast storm warnings were ordered for the Texas coast. The storm moved westward into Mexico and reports indicate that it was the most severe that has visited the section near the mouth of the Rio Grande in several years. —*I. M. Cline, District Forecaster.*

LOUISVILLE FORECAST DISTRICT.*

[Kentucky and Tennessee.]

The periods 6–10th and the last eight or nine days of the month were unusually warm. About the middle of the month there were several cool waves of short duration. Rainfall was in excess in eastern Kentucky and central Tennessee, and was deficient in other portions of the two States. Thunderstorms were frequent and there was some minor damage from lightning and local squalls.—*F. J. Walz, District Forecaster.*

CHICAGO FORECAST DISTRICT.*

[Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, and Montana.]

No storm warnings were issued for the upper Lakes. One frost warning and two advisory warnings were sent to the cranberry marshes of Wisconsin which enabled the growers to anticipate the occurrence of frost.—*H. J. Cox, Professor and District Forecaster.*

DENVER FORECAST DISTRICT.*

[Colorado, Wyoming, Utah, Arizona, and New Mexico.]

Precipitation was deficient except on the middle-eastern slope, a feature of the month being the persistency of rainfall in southeastern Wyoming, where the amount was the greatest for June of record. Special warnings were issued for high water in the Grand, Colorado, Arkansas, and Rio Grande rivers. The freshets in these streams were due to melting snow and the fluctuations followed closely changes in temperature.—*F. H. Brandenburg, District Forecaster.*

SAN FRANCISCO FORECAST DISTRICT.†

[California and Nevada.]

The month was one of quiet weather. The first decade was cool and the second unusually cool. The third decade was warmer, and on the 23d temperature rose to 100° in the Santa Clara Valley, and to 94° in the San Francisco Bay cities. This was the warmest day recorded for four years. It is interesting to note that a dry period, extending about seventy-six days, was broken June 17 by light rains. Such rains are unusual in June. They were forecast with precision.—*A. G. McAdie, Professor and District Forecaster.*

The following letter from Professor McAdie calls attention to a warning given to a vessel that evidently was lost because the warning was not heeded:

> SAN FRANCISCO, *June 23, 1909.*
>
> I inclose a clipping relative to the British tugboat *Grayling* and the American steamer *President*, Captain Cousins, Master. I have verified the facts in the case as far as possible and interviewed the reporter who wrote the article and who spoke directly to Captain Cousins.
>
> I would be glad if the Chief of Bureau would give publicity to this kindly act of Captain Cousins. There are few men in command of large passenger steamers (where the minutes count and where every ton of coal is checked) who would go out of their course to give warning to a smaller vessel. It was the action of a generous and humane man. May the time speedily come when all masters will feel it incumbent upon themselves to do all they can to be of service to others under such circumstances.

The following from the San Francisco Examiner of June 20, 1909, is referred to in the above quoted letter:

> The British tug *Grayling*, which sailed from British Columbia for San Francisco on the way to Ancon, is given up as lost. She sailed on May 31 and should have reached port in three days. She had only eight tons of coal on board, which in ordinary weather would last four days. The last seen of her was when passing Cape Flattery on the Sound, when she passed out two miles ahead of the steamer *President*.
>
> Captain Cousins of the *President* saw the danger the little vessel was in, and fearing she was not aware of an approaching storm, steered to the *Grayling* and hailed her. Cousins considered her situation so precarious that he went out of his way a mile to warn her.
>
> When alongside the *Grayling* Cousins told the skipper of the latter that the Weather Bureau had predicted a violent storm. The warning was not acted upon, and as nothing has been heard from the *Grayling* since it is believed she foundered with all on board.

RIVERS AND FLOODS.

The Missouri River continued to rise during the first three weeks of the month, and stages slightly above the flood stage were reached between Blair, Nebr., and Boonville, Mo. Heavy rains in the Black Hills regions during the latter part of May and the first decade of June resulted in general floods in all the western tributaries in the State of South Dakota, and much damage was done to mines, irrigating plants, and crops. The

* Morning forecasts made at district center; night forecasts made at Washington, D. C.

† Morning and night forecasts made at district center.

effects of these floods were felt in the Missouri River early in June, and more or less overflow occurred between Yankton, S. Dak., and the mouth of the Niobrara River. Considerable damage was done to hay and pasture lands in this section while in the Black Hills region the losses amounted to about $500,000. Warnings to remove stock and portable property were issued in ample time.

Nothing of special interest occurred along the Mississippi River. The lower river remained quite high at stages a few feet below the flood stage, a rise from the Ohio and upper Mississippi rivers coming down before the flood waters of the previous month had passed out. In the Vicksburg, Miss., district crops to the value of $150,000 and other property to the value of $10,000 were destroyed.

The upper Mississippi River was slightly above the flood stage in the vicinity of Hannibal, Mo., on the 12th and 13th on account of heavy rains above, and was again rising rapidly at the end of the month under the influence of heavy rains and a decided rise over the watershed of the Des Moines River. The Illinois River was above the flood stage during much of the time, but there was no resulting damage of consequence.

Excellent boating stages prevailed along the Ohio River.

The heavy rains of the 2d and 3d over the South Atlantic States caused general floods in the rivers of the Carolinas, and warnings were issued on those days. Livestock, etc., to the value of about $75,000 were saved, and crops to the value of about $25,000 were destroyed. The floods in the Tombigbee River and the rivers of central and southeastern Mississippi about the same time were noted in the Monthly Weather Review for May, 1909.

The freshets in the Grand, the Colorado, the upper Arkansas, and the Rio Grande were fully covered by special warnings issued while the unmelted snows still covered the mountain slopes. The freshets were due to the melting snows, and the fluctuations, the greatest in many years, followed closely the changes in temperature.

The annual rise in the Columbia River reached its maximum at Portland, Oreg., on the Willamette River, on the 21st with a crest stage of 21.6 feet, 6.6 feet above the flood stage. A report on this rise will be made later.

The Sacramento River remained at moderate stages, while the San Joaquin was generally above flood stage, though only moderately so, and without unusual incident.

The highest and lowest water, mean stage, and monthly range at 215 river stations are given in Table IV. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

ANNUAL RISE OF THE COLUMBIA RIVER, 1909.

By E. A. Beals, District Forecaster, Portland, Oreg.

The two principal features to be considered in connection with the annual rise of the Columbia River are the amount of snow in the mountains within the drainage area of that stream at the close of the cold season and the subsequent temperatures in relation to their effect upon the melting of this snow. Summer thundershowers also affect the behavior of the rise, but their importance is insignificant as compared with the other two factors. Reports received at the end of March from Weather Bureau sources showed that the snowfall at the headwaters of the Snake River was unusually heavy and well packed, and reports from the Canadian Meteorological Service and from the Weather Bureau showed the snowfall at the headwaters of the Columbia River to be heavier than last year and in some places to be above the average for a number of years. During the spring months the newspapers published, from time to time, items stating that the snow was very heavy in the mountains within the drainage area of the Columbia River.

The temperature and precipitation data for the northern Plateau as published in the Monthly Weather Review reflect fairly well the conditions prevailing at higher elevations in the same localities, and as this district is largely within the Columbia River Basin, a table showing these data follows:

Table 1.—*Temperature and precipitation of the northern Plateau during the cold season*, 1908–9.

Month.	Temperature.		Precipitation.	
	Mean.	Departure.	Average.	Departure.
1908.	°	°	*Inches.*	*Inches.*
November	42.0	+3.0	0.83	−0.55
December	30.4	−1.8	0.80	−0.90
1909.				
January	29.0	+0.3	2.72	+1.10
February	37.7	+5.6	1.90	+0.50
March	43.2	+3.0	1.01	−0.60
	36.5	+2.0	7.26	−0.45

The northern Plateau precipitation, as will be seen by the foregoing table, was 0.45 of an inch below normal and the temperature was 2° above normal. The precipitation was heavier than usual in January and February and below normal during the other months when the precipitation was likely to be mostly in the form of snow. The backward spring kept the snow from melting in the mountains until very late in the season.

The reports of heavy snow in the mountains combined with the backwardness of the spring caused the people affected by the annual rise of the Columbia River to become unduly alarmed, and many irresponsible people made predictions that the rise this year would exceed that of all former years. Telegraphing of river reports to this office began on March 1 and they were continued until the latter part of June from nearly all the stations and from a few of the most important stations till the end of July.

The river did not begin to show any material rise until the third decade in June, but it was necessary to have the reports telegraphed in order to allay the alarm of the people living in the flooded areas, and who were expecting a big rise on account of the alarming reports that had been disseminated by the newspapers.

During the entire rise accurate forecasts of the height that the water would reach were issued from this office covering periods of from four to six days in advance of their appearance. At no time did the stage reached fall short of the stage forecast by more than a few tenths of a foot and the forecast for the crest of the flood was only two-tenths of a foot higher than the stage actually reached.

Table 2 shows the crest stages at all the river stations affected by the rise.

It will be noticed on the hydrograph, Fig. 1, that there were two crests at Portland, an unusual occurrence. For the purpose of comparison Table 3 presents the stages of all the recorded flood crests at Portland, Ore., due to the annual rise in the Columbia River.

After the first crest of 20.5 feet was reached on June 10 many people affected by the rise thought that this was the highest stage that would be reached, but all were told that the river might rise again and advised not to place their goods in jeopardy until they were assured that the danger had passed. This advice was well received and when the second rise oc-

curred no losses ensued, in fact no movable property was lost in this city or in the country on account of the flood. The only damage, so far as learned, was to crops where farmers had planted them in the spring on bottom land, taking chances of their being inundated. Losses of this character, however, were smaller than usual, as most of the farmers were expecting a big rise and were prepared for it. The river at Portland was above the flood stage from June 4 to July 17, inclusive, or 44 days in all. Part of this time it was as much as six feet above the flood stage and the utility of the service can not be questioned when it is considered that vast quantities of goods were moved to places of safety without any losses whatever except the extra cost of moving.

TABLE 2.—*Flood crests, Columbia River drainage, 1909.*

Stations.	Height.	Date.
	Feet.	
Weiser, Idaho	12.6	June 7
Lewiston, Idaho	19.0	June 5
Riparia, Wash.	17.8	June 6
Bonners Ferry, Idaho	27.9	June 6
Newport, Wash.	18.6	June 25
Northport, Wash.	32.9	June 23
Wenatchee, Wash.	39.7	June 24
Kennewick, Wash.	19.4	June 20
Umatilla, Oreg.	22.6	June 18
Celilo, Oreg.	19.3	June 20
The Dalles, Oreg.	38.1	June 19
Cascade Locks, Oreg.	30.1	June 20
Vancouver, Wash.	22.0	June 22
Portland, Oreg.	21.4	June 21

TABLE 3.—*Flood crests at Portland, Oreg., during the annual rise of the Columbia River.*

Year.	Stage.	Year.	Stage.
	Feet.		*Feet.*
1879	19.3	1895	16.3
1880	27.3	1896	23.8
1881	19.7	1897	23.7
1882	26.1	1898	20.7
1883	17.8	1899	24.2
1884	20.2	1900	17.8
1885	14.5	1901	20.8
1886	20.0	1902	20.7
1887	25.7	1903	24.0
1888	18.2	1904	20.8
1889	10.0	1905	13.6
1890	20.1	1906	13.4
1891	14.1	1907	19.2
1892	19.3	1908	21.2
1893	22.0	1909	21.4
1894	33.0		

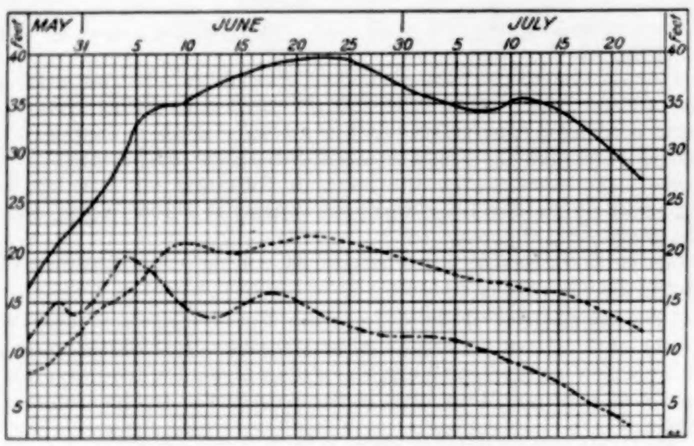

FIG. 1.—Hydrographs of daily stages on the Columbia River system, June and July, 1909.

—— Columbia River at Wenatchee, Wash.
– – – Snake River at Lewiston, Idaho.
- - - - Willamette River at Portland, Oreg.

FROST DAMAGE PREVENTED BY COVERS.

Prof. A. G. McADIE. Dated San Francisco, Cal., June 23, 1909.

A recent letter from Eastern Agricultural College, Wye, Kent, England, brings up the question whether it is the heat or the smoke developed by the fires and smudges of frost-fighting apparatus, which prevents the damage by frost in orchards, vineyards, etc.

The great mass of experiments made in California orchards show that direct heating of the air by open fires has not been sufficient to prevent injury at times of very low temperatures. A large amount of the heat thus produced is wasted; the efficiency of the method is low. This is illustrated by the following experience of a gentleman who is a close observer, an earnest student of the problem of frost-protection, and one in whom I have the greatest confidence. During the night of December 20–21, 1908, on a certain California ranch, the temperature for fourteen hours ranged between 19° and 24° F. For thirty-six hours the temperature did not rise above 28°. During this night the gentleman referred to burned 15 cords of wood and about 40 tons of wet hay in his efforts to protect his orchard. The relative humidity was low, there was little movement of the air, and he reports that "the smoke rose as straight as a pine tree." At the intersection of two roads in the orchard a large fire was maintained, and 30 feet distant the temperature in an olive tree was observed. Another fire was burning within 20 feet of this tree on a second side, and on yet a third side was a third fire maintained within 25 feet of the same tree. The temperature at the tree, however, remained at about 20° F. from 3 to 8 a.m. of December 21. This was the coldest weather in this locality since 1888. It is evident that in this case a large amount of heat escaped without producing the desired warming effect, i. e., was lost, wasted. It is, of course, well known that the rate of conduction of heat through air is low.

Other evidence has led me to the conclusion that open fires of coal, oil, etc., in wire baskets, in pots, on the ground, or indeed any source of heat will not, unaided, serve to protect plants under *severe* conditions. The oil pot is objectionable both because of its low efficiency and because the soot from it may settle on the fruit. The briquette has similar drawbacks and also is troublesome to ignite. The small sheet-iron stove is more satisfactory and the heat radiated by it is not lost to the same degree that it is from other devices. It has the additional advantage that it warms the air near the ground whence by a step-to-step process the heat is conducted to the higher strata, i. e., those 10 to 16 feet above the ground, thus affording protection to the branches of the deciduous fruit trees also.

The ideal method of frost protection is a combination of a cover device and a heating device. The cover, properly placed, prevents the excessive loss of heat from the soil, plants, and objects beneath it, and it may be stated that the heat energy involved is much greater than that given for the same area by a number of brisk fires burning for hours. By conserving the earth's heat we employ the very cheapest heat energy that can be obtained, notwithstanding the initial expense of the cover. A proper cover is, in my opinion, the most effective means of protection against injury to plants from low temperatures. Furthermore, the locations most subject to frost are the low points, vales, hollows, and depressions. Elevated valleys shut in by hills are especially bad. We now clearly recognize that the conditions of *air drainage* must be studied for any given locality. Many investigations could be quoted proving the correlation of low temperatures with the low levels. Consequently a cover spread some feet above the surface where there is a particularly frosty spot would by its mechanical interference with the flow of the air, as well as by obstructing the radiation of heat, prevent injury by frost.

It is my opinion that those who claim that "heat and not

smoke" is what prevents damage from frost, are not altogether correct in their statements. The pots for open coal fires are effective only in part and over quite limited areas. For low temperatures the proper method is to use a cover, and supplement this, if necessary, by small stoves and shallow pans of hot water.

THE FIREBALL OF SEPTEMBER 20, 1909.

By Prof. FRANK W. VERY. Dated Westwood, Mass., September 21, 1909.

At about twelve minutes before 8 p. m., ± three minutes, my wife saw a fireball low in the NNW. When first noticed it was near β Ursæ Majoris, and descended in a vertical direction to the horizon in about two seconds. There was a bright nucleus, apparently several minutes in sensible diameter, which was surrounded by a pale green coma of circular shape and about as large as the full moon when seen near the horizon. The appearance was that of a white light seen through a green gauze. The brightness of the entire object was perhaps half that of the crescent moon then visible low in the western sky, but instead of the yellow tint which the moon would have had if near the horizon, the fireball exhibited a decided green color, although it would be called a pale green, i. e., a mixture of green and white. The motion was a halting one, an alternate slowing and quickening, repeated twice or thrice. This may have represented a real revolution in a vertical plane about a more massive, but less luminous companion bolide.

If we assume that the meteor, when first seen, had an altitude above the horizon of 11.5° (sin=0.2) and a height above the earth's surface of 60 miles, its distance was roughly about 5 × 60=300 miles, and the real diameter of the coma would have been about 3 miles. The greenish color may have been due to the prominence of the green carbon band in its spectrum, and if so, the coma may have been a flame of carbon or hydrocarbon particles continuously produced from the nucleus and as rapidly consumed. If the bolide were moving 15 miles per second it would pass through the diameter of the coma in 1/5 second, and this time interval must represent approximately the duration of the flame, since there was no appreciable elongation of the coma. This gives for the velocity with which the particles (of carbon?) were expelled from the nucleus 1.5/0.2=7.5 miles per second, or one-half the assumed speed of the bolide, which is not an improbable figure. Bearing in mind the extreme rarification of the oxygen atmosphere at a height of 60 miles, carbonaceous particles, even in an extremely fine state of division, may plausibly be assumed to travel through a distance of $1\frac{1}{2}$ miles, the radius of the coma, before being entirely consumed.

The light was such as may have come from white hot incandescent particles of carbon or other solid material, mixed with a green gaseous flame. The intensity of light from the full moon being about 1/6 candle-meter or 1/50 candle-foot, that of the crescent moon may have been 1/500 candle-foot, and that of the fireball 1/1000 candle-foot. At a distance of 300 miles=1,584,000 feet this gives a total original brightness equal to that of a million powerful arc lights of 2,500 candles each. This distributed over a section of 21 million square feet gives 119 candle power per square foot. But since the actual composition of the coma was probably not that of a continuous flame, but rather that of a swarm of minute flaming particles separated by wide spaces, the intrinsic brightness of the flame can not be found.

TORNADOES IN KANSAS.

On the afternoon of June 24 there was a series of about seven tornadoes within a radius of 20 miles in Norton County in the northwest part of the State, and great damage was done to live stock and buildings, but, fortunately, no person was killed though there were a number of very narrow escapes. The one farthest north formed near Devizes and moved northeastward through Hendley, Nebr. Four or five other tornadoes formed from 4 to 10 miles northwest of Norton, each moving toward the northeast. In their paths houses, outbuildings, fences and windmills were destroyed and in some instances entirely blown away. About 83 head of live stock were either killed or badly injured. These disturbances were accompanied by heavy hail over narrow bands of country and a violent thunderstorm. The cloud of the last of this group of tornadoes resembled the letter "S" lying on its back thus ∽. The seventh tornado formed about 6 miles north of Lenora. It was a vertical column and moved slowly, traveling only about 4 miles in forty-five minutes, and people had time to get out of its way. The paths of the tornadoes were from 120 to 400 feet wide. The value of the property destroyed is estimated at $22,500. Further details are given in the Monthly Climatological Report, Kansas Section, for June, 1909.—*T. B. Jennings.*

TORNADOES IN MISSOURI.

(Extract from Monthly Climatological Report, Missouri Section, June, 1909.)

The weather map of June 22, 1909, showed a barometric depression over most of the territory lying between the Mississippi and the Rocky Mountains, and extending from Sonora, Mexico, to Manitoba, Canada, with rather well-developed lows at both extremes. On either side of the depression were fairly well-formed highs, one resting over the South Atlantic States and the other over the north Pacific slope. On the east side of the low area the temperature gradient was decidedly flat, the isotherm of 70° passing through the middle and following the general trend of the depression; on the west side there was a temperature gradient of about 30 degrees in 500 miles.

While this distribution of pressure would indicate thunderstorms, or more accurately thundershowers, one would hardly expect tornadoes. Yet, several severe local storms having tornado characteristics occurred in Missouri on the date mentioned. The most noteworthy of these occurred near Monett, Barry County, in the southwestern part of the State. The tornado, which, from reliable reports, had a well-defined pendant funnel-shaped cloud, was first seen between 8 and 9 p. m., central time, about 3 miles southwest of Monett, whence it moved eastward leaving the ground when about 3 miles southeast of that village; thence it travelled northeastward, again touching the ground about 12 miles northeast of Monett near Aurora, Lawrence County, where, however, it did no damage, and then disappeared.

The section of country over which the storm passed is comparatively thinly settled. The storm's path averaged about 350 feet. From the evidence furnished by fallen trees and other wreckage, there must have been a decided rotary motion to the storm. The estimated damage and loss to property and live stock was about $8,000, of which at least $1,000 is covered by tornado insurance. Only one person was killed, so far as could be ascertained, and seven injured. Some fish were found a quarter of a mile from a pond which lay on the path of the tornado.—*George Reeder.*

WEATHER CYCLES IN THE GROWTH OF BIG TREES.

By Prof. A. E. DOUGLASS, D. Sc. Dated Tucson, Ariz., October, 1908.

NOTE BY THE EDITOR.—Inasmuch as it was impossible to reproduce in the Monthly Weather Review the diagrams furnished by Professor Douglass, the Editor asked him kindly to furnish the table of original measurements so that students of this interesting subject may have at hand the valuable material for further investigations, which indeed now gives this memoir a specially high value.—*C. A.*

Climatically Arizona is divided into two parts, the northern, a great plateau at an average elevation of 6,000 feet, and the southern, a broken country consisting of scattered mountain ranges separated by broad level valleys averaging some 2,000 thousand feet above the sea. The higher elevations,

culminating in the San Francisco Peaks near Flagstaff, are covered with great forests of yellow pine (*Pinus ponderosa*), a fine timber tree with heavy cylindrical trunk and a rather bushy top. The trees are scattered gracefully over the plains and hills and, with the remarkable absence of undergrowth, render travel through their shady midst attractive and delightful.

Contrary to Arizona's reputation, northern Arizona has really a cold climate. Several feet of snow lie on the ground during winter, and the summer evenings are rarely warm enough for one to sit outdoors. For centuries these magnificent pines have stood there enduring all the vicissitudes of heat and cold, flood and drought. They should contain some record of such alternations. Other studies of weather variations have been made upon records extending back from twenty to fifty years. These trees, if they prove to convey such information at all, will yield data covering two to five centuries.

The working hypothesis which in 1901 and before gave a beginning to the collection of material along these lines was as follows: (1) the rings of a tree measure its food supply; (2) food supply depends largely upon the amount of moisture, especially where the quantity of moisture is limited and the life struggle of the tree is against drought rather than against competing vegetation; (3) in such countries, therefore, the rings are likely to form a measure of the precipitation. In planning the work three fundamental steps were anticipated. First, to prepare a curve of tree growth; second, to find if there exists in this any connection with precipitation; third, by carrying this back through long periods to find whether meteorological variations, if discovered, show association with astronomical phenomena.

REASONS FOR PURSUING THE INVESTIGATION.

That tree growth does give a fairly accurate record of precipitation in its own vicinity is evident from an examination of the accompanying figure (fig. 3). In it the curve of annual growth represents the average of 25 trees for the eight years during which the United States Weather Bureau station has been located at Flagstaff, Ariz. The trees were scattered over an area of 12 to 15 miles in extent near that town. The curve of rainfall gives the annual precipitation for years beginning November 1. This division of the year is taken because precipitation in November and December is almost invariably in the form of snow, and its benefit to the trees goes over into the following year. Evidently this arboreal new year depends on temperature.

It is at once apparent that the annual tree growth becomes a very close measure of the annual precipitation.[1] A similar agreement over longer periods of time is shown in fig. 4, where a comparison is made between the tree growth derived from the first six trees, and the average precipitation over longer periods at more distant stations. The rainfall curve is a "nine-year smoothed" curve from Prescott, Ariz., distant 67 miles southwest. By "nine-year smoothed" is meant, not the precipitation for each year in its place, but the average of a nine-year group. As in these longer periods we are studying the general condition of the country rather than the individual year, and as good or bad conditions of the country require much time, perhaps years, to be overcome, the average of each of these groups of nine is placed at the end of the group instead of at its center. A strong connection between the precipitation at Prescott and the annual tree growth nearly 70 miles distant is evident. A general consideration of this topic leads me to the opinion that the agreement between tree growth and rainfall is fairly close in the neighborhood of the trees, but that for more distant localities, such as Prescott, Ariz., (67 miles southwest), and the California coast (500 miles west) the agreement in individual years is not to be expected, although averages of three or more years show strong similarity.

[1] Prof. E. E. Bogue, of Lansing, Mich., in the Monthly Weather Review of June, 1905, finds this connection.

ONE RING TO A YEAR.

In comparing rings and the rainfall over long periods of years, a preliminary condition is that the time of formation of any individual ring shall be subject to identification. As a rule the individual rings of the trees are extremely well marked and leave no doubt whatever as to their purely annual or seasonal character. However, doubtful cases occasionally appear, with greater frequency near the center of the tree. For the last two hundred years, I estimate that 2 per cent is the average number of doubtful cases. The arguments bearing upon this subject are as follows: (1) the agreement shown in fig. 3 between tree growth and rainfall in individual years shows the yearly character of the rings; (2) at the 7,000 feet of elevation at which these trees grew, the seasons are very sharply defined; the mean temperature for January is 29° F., and for July is 65° F.; frost, therefore, gives a sharply seasonal character to the growth; (3) the examination of stumps and logs at different seasons during several years showed entire consistency in the formation of a narrow red ring in autumn and winter and a broad, soft white ring in summer; (4) in the investigation of uncertain cases, it is a great help to trace the doubtful ring around different portions of the tree. In some other part, the ring's claim to individuality is often clearly settled.

In deriving the tree growth since the year 1700 it may be assumed that as many errors have been made in one direction as in the other, and they therefore neutralize each other. Their effect is simply to lessen the intensity of the variations in the tree. As to location of errors, I doubt if there are any appreciable ones subsequent to 1760. Practically all the estimated 2 per cent of cases come between 1700 and 1760. On account of the comparative frequency of doubtful cases in the early rgs inof a tree, these rings were not made use of in forming the means.

COLLECTION AND MEASUREMENT OF SECTIONS.

In January, 1904, I visited the log yards of The Arizona Lumber and Timber Co., Flagstaff, and spent several hours in the snow, measuring the rings of section No. 1. For all subsequent numbers Mr. T. A. Riordan, President of the Company, most kindly came to my assistance by having thin sections cut from the ends of logs or stumps and sent to me in town, there to be measured more conveniently. Sections VII to XXV were cut at my direction on the spot where the tree grew, and where I was able to mark the points of the compass on the sections and otherwise identify and describe their location. These 19 sections were freighted to Tucson, where the work work on them has been done.

The measures consist in determining the radial thickness of each annual ring in millimeters. For this purpose a steel meter rule was placed radially on the section, and by the aid of a magnifying glass, the position of every ring was read off on this scale. Mr. Willard P. Steele rendered most valuable assistance as recorder. The average age of the trees was three hundred and twenty-four years. With the extra measures taken for one purpose and another the total number of original measures was nearly ten thousand, and subsequent calculations have tripled that number. The rings proved remarkably susceptible to measurement. That which I call the winter or autumn ring is a thin, hard, pitchy ring, somewhat indefinite on the autumn side but sharply bounded on the spring side. That sharp side was therefore the point measured. The substantial growth of the tree consists of a wide, white, pulpy summer ring. Under the microscope the winter cells look lean and emaciated, while the summer cells are round and well fed.

REDUCTION.

Lists were then made of the sizes of individual rings of every tree, and these again were combined into three groups, consisting of *A*, six trees from about 3 miles south of Flagstaff; *B*, nine trees from about 12 miles southwest of Flagstaff;

and *C*, ten trees a mile east of the last group. I take this opportunity of thanking several persons who assisted me in these reductions.

These groups, as above described, were studied in order to differentiate between accidental variations in the individual tree and general variations due to some prevalent external cause. Any given characteristic found in these three groups separately could certainly be relied on as due to some cause outside the trees. A comparison clearly reveals the entirely general character of the longer periodicities hereinafter discussed, and shows also many lesser variations common to the three groups.

One interesting group characteristic is brought out by a knowledge of the location at which the trees grew. It will be noticed that the group *A* of six dropped to its strong minima in 1780 and 1880 more promptly than the others, *B* and *C*. This appears to be connected with the soil upon which the trees grew. Group *A* stood on a limestone formation where the soil is porous and the rocks below full of cracks. The other groups grew on recent lavas, very compact and unbroken, covered with a rather thin layer of clayey soil. With the former, *A*, therefore, the rain passed quickly through the soil and away, and we do not see so much of the conservation of moisture as in the other groups where the water could find no convenient outlet.

ANALYSIS OF THE CURVE.

The average of the three groups, *A*, *B*, *C*, gives us the final curve of tree growth. The large pronounced minima here shown had been previously found in the separate groups. The strong minima in the years 1880, 1845, etc., gave an average period of about thirty-three years. But it was also evident that a shorter period of about twenty years was producing a well-marked effect. The combination of these two periods altered the time of observed maxima and minima to such an extent as to hide the true values of the periods. The two curves were separated in the following manner. A thirty-three-year smoothed mean was made. This being the period of the longer variation, the longer variation itself disappears; but as this is one and one-half times the shorter variation the latter remains in the curve as a smothered reversed curve. The regular fluctuations in a period of 21.2 years are evident enough on close scrutiny.

Having the 21.2 variation isolated, it was easy to separate the other, which proved to be closely 32.8 years. Harmonic curves representing these two periods are shown in the lower part of the figure. Their combination is shown in the uppermost curve, drawn close to the curve of tree growth for ready comparison. The accordance in all pronounced variations is most striking. If one were given this combined harmonic curve and told to compare it with the annual growth of 25 trees in the great forest of northern Arizona, it would be quite beyond the possibility of mere accident that he should find the exact agreement exhibited.

As a check on the preceding result the older trees were selected and an average of seven taken over a period of three hundred and fifty years. In addition to that, the oldest two were averaged for a period of four hundred and seventy-five years. At the top of fig. 9 is placed the harmonic curve derived as described in the last paragraph. These check curves support the results obtained.

BOTANICAL CURVES.

One point of great botanical interest has already been mentioned, namely, the immediate correspondence between yearly rainfall and tree growth. Another important point has been touched upon, namely, the speed of growth in relation to the soil beneath. On the whole, the growth seems to be more rapidly influenced by changes of moisture upon limestone than upon volcanic rocks. I am not sure that there is much real difference in average speed. Another point appeared in fig. 8, in the line of tree growth uninfluenced by external factors. That rate of tree growth is represented in fig. 10 where the relation between growth and radius is illustrated in the upper part of the figure. If the trees were simply increasing in diameter without growing upward, the size of the rings would be inversely proportional to the radius of the tree section, other things being equal. If the food of the tree were distributed in upward growth as well as in circumferential increase, the size of the rings would be inversely proportional to the square of the radius. It will be seen that the actual curve of growth is between these two.

The lower section of this same figure gives the point of the compass toward which the maximum trunk growth occurs. It is a little east of north. This result comes from the 19 trees of groups *B* and *C*. The average variation between the maximum growth in the northerly direction and minimum growth to the south is 12 per cent. The explanation of the increased growth to the north is in the increased amount of moisture on that side, due to the slower melting of snow and the decreased evaporation in the shade. For nearly all these trees, also, the ground had a gentle slope toward the south, so that moisture working down hill would come to the north side first. All of these facts agree in pointing to moisture as the factor of greatest influence in tree growth. It appears probable that the red winter rings in the trees are governed directly by lowness of temperature, and the white rings by abundance of moisture.

SUGGESTIONS OF SHORTER PERIODS.

There are portions of the curve of tree growth which suggest a six-year variation, e. g., 1840 to 1870, also 1740 to 1760, represented in fig. 11 and others. In attempting to find connection, if any, between the longer growth variations and meteorological elements on the California coast, the precipitation in the latter region was reduced to a nine-year smoothed curve as shown in the figure. On plotting this curve, a six-year variation became at once evident. This shows remarkably in the exhibited curve of "'Frisco" rainfall. The minima appear almost equally well-marked in the San Diego curve, and a trace of them may be discerned in those of Yuma and Prescott. The rainfall curves of Santa Fe and El Paso seem to be reversals of the coast types.

This six-year variation is apparent in the rainfall of San Francisco for the last half century as published on page 11 of "Climatology of California," by Alexander G. McAdie (Weather Bureau Bulletin L). In this diagram, the minima show a fair distribution on a six-year interval.

Both in the San Francisco rainfall curve mentioned and in the curves of the last figure these six-year periods appear to go in pairs, forming a full period of between eleven and twelve years. In the temperature curves in fig. 12, the approximately eleven-year character of the curve is more apparent. For example, the Sacramento annual mean temperature has maxima in 1854, 1864, 1875, 1885, 1896. The San Diego temperature curve has minima in 1859, 1870 (or later), 1880, 1894. The average value of this periodic change in many curves is 11.3 years, and it is upon this period that the investigation is continued.

ELEVEN-YEAR PERIOD.

Variations of weather elements in the eleven-year period are not new (see Prof. F. H. Bigelow's "Studies of the Diurnal Periods in the Lower Strata of the Atmosphere," MONTHLY WEATHER REVIEW, July, 1905).

At the top of the figure is found the annual mean precipitation for the last fifty years, at San Francisco (the dotted line) and San Diego (the broken line), and their average (the continuous line), plotted in a period of 11.3 years. This curve shows two well-marked maxima dividing the whole interval into two similar halves.

So far as this curve is concerned, the variation is on a 5 2/3-

year period. But this curve is so closely related to the curve of temperature below it that it is still best to regard it as having the double length.

The temperature curve is derived from the San Diego records since 1851, and shows the unmistakable eleven-year period, since it can not be divided into two equal parts. Below that is given the inverted sun-spot curve for the years 1864 to 1874, plotted from Young's General Astronomy. Lastly is given the 11.3-year period of tree growth, including the final averages of 25 tree sections for the years 1701 to 1906, inclusive. In order to effect a comparison between these curves, they are all calculated as beginning at the same epoch—namely, the year 1863.0—and in the figure the period is divided into ten equal parts. Each part therefore represents a little over one year.

Now, to express the causal relation between these phenomena, one should consider first the inverted sun-spot curve. The sun-spot minimum occurs at a point between .3 and .4 along the interval, and the maximum occurs between .7 and .8. The sun-spot minimum is accompanied by, and presumably causes, the temperature maximum, the sun having fewer "cooling spots" on it. The difference thus produced between maximum and minimum temperatures is nearly 2° F. The temperature maximum, at .3, is quickly followed by, and presumably causes, the maximum in precipitation. The rise to the average from the minimum temperature accompanies the second maximum in precipitation. The proportionate total variation of rainfall is over 40 per cent of this mean. It is a longer jump[2] than one likes to go from coast rainfall to northern Arizona tree growth; but that is the best we can do and use long series of weather observations. The tree-growth curve has the same form as the rainfall curve, except that it drops more quickly from maximum to minimum. Its variations are in the neighborhood of 3 per cent.

MEANING OF THE LONGER PERIODS.

The tracing of the short variations in tree growth to solar influence suggests a cause for longer periods. In fig. 14, at the top, is a smoothed curve of San Diego temperature, and below it a smoothed curve of Prescott precipitation. The connection between these is of the same sort and just as striking as that between the coast temperature and rainfall. Below the Prescott curve is the smoothed curve of tree growth showing, as is entirely reasonable, a delay of a few years in reaching its minima and maxima; for the general effect of good and bad years on the trees may last for some time. This lagging is well seen in a direct comparison between the coast temperature and the tree growth, and amounts to perhaps six or seven years. The amount of the tree growth variations is immense, fully reaching 25 per cent above and below the average. These longer variations therefore indicate far more profound and immense fluctuations in their cause than the lesser inequalities.

But as the causal relation from solar activity to tree growth is found in the lesser inequalities, it seems fairly evident[2] that the cause of the longer variations is to be found in solar changes of great magnitude in periods of approximately 21.2 and 32.8 years. The intensity of these variations, judging by their effects, may be even as much as eight times greater than the solar changes involved in sun-spot phenomena.

SUMMARY.

The following is a summary of the periods here observed.

In tree growth:

I.	32.8 years.	Minimum in 1880.6.
		Variation about 25 per cent from mean.
II.	21.2 years.	Minimum in 1884.3.
		Variation about 7 per cent from mean.
III.	11.3 years.	Minimum in 1863.5.
		Variation about 3 per cent from mean, but extremely variable.

In weather elements:

IV.	11.3 years.	Variation in coast rainfall.
		Minimum in 1865.2.
		Variation 20 per cent from mean.
V.	11.3 years.	Variation in coast temperature.
		Minimum in 1864.5.
		Total variation 1.80° F.

Since the variation in tree growth in the eleven-year period averages only 3 per cent and in the longer period averages as high as 25 per cent, it is evident that we are in the latter considering factors of most profound influence upon biological conditions upon the earth. Such factors could easily affect crops and all products of a vegatational character, and full knowledge regarding them is of the utmost importance. If my reasoning has been correct, therefore, we have now made a beginning of definite knowledge of these factors by aid of the great pine trees of northern Arizona, and have established a method of study worthy of extension to other great forests of the world.

NOTES FOR TABLE I.

Table 1 presents the original scale readings from which can be derived the yearly growth for each of the 25 trees discussed in the accompanying text. The first column gives the year near whose close the outer edge of each dark pitchy "annual ring" is supposed to have been formed.

The following significant letters or marks are used throughout the original manuscript table and will give the reader an idea of the care with which the observations were made; but it has not been practicable to print all the items in detail in our present table.

[ ], square curves inclose the scale reading on the edge of a ring or on a secondary ring. The small percentage of uncertainty in secondary rings has been referred to in the text.

{ , the brace joins two rings that I judge to be separate, but about which there is a question.

—, a dash between a reading and a bracketed reading indicates that the ring is continuous between the two; the bracketed gives the inner edge.

"At," the letters "At" mean that the secondary ring is attached to the

[2] Most climatologists will agree that the great distance and complete topographic change covered by this "jump" are sufficient to make abortive any attempt to correlate Pacific coast precipitation with tree growth in northern Arizona.

Concerning the supposed influence of sun spots on terrestrial temperatures, rainfall, tree growth, etc., the reader is reminded that this whole question of sun spots and terrestrial meteorology still remains in the realm of speculation and has not advanced beyond. It is to be noted that in the present work Professor Douglass finds that sun-spot minima are epochs of rainfall maxima and temperature maxima. In the work by Bigelow which he quotes (Monthly Weather Review, November, 1903, **31**: 515, fig. 13), Bigelow finds that the temperature curves vary directly with the sun-spot curves on the Pacific coast, are indifferent to them in northern Arizona, and vary inversely with them in the west Gulf States.

On the other hand, while Bigelow and Douglass seem to disagree about the relation between sun spots and temperature, Newcomb, Koeppen, and others have found that the synchronism between sun spots and temperature fluctuations is very hard to perceive and that the temperature residuals are insignificant. In a recent monumental work (Trans. Amer. Phil. Soc., 1908, **31**: 309–387) Newcomb has demonstrated: (1) That the eleven-year period in temperature has an amplitude of but 0.26° C. or 0.47° F.; (2) That the epochs of maximum temperature precede the sun-spot minima by 0.33 year, while the minimum temperatures follow the sun-spot maxima by 0.65 year. Newcomb comes to the general conclusion that "*all the ordinary phenomena of temperature, rainfall, and winds are due to purely terrestrial causes, and that no changes occur in the sun's radiation which have any influence upon them*" (p. 384). C. G. Abbot (Ann. Astrophys. Obs., Sm. Inst., 1908, **2**: 177–201) finds that "the intensity of solar emission varies considerably" and that the average temperature of a large number of inland stations is above the normal at the time of the sun-spot minimum "so that the solar radiation is more intense at the sun-spot minimum," but he also finds that the temperatures are about normal at the sun-spot maxima, and that the temperatures show but 0.6° C. extreme fluctuation on either side the normal.

The question of a causal connection between sun-spot frequency and the growth of the great Arizona pines is evidently not yet settled. Our readers will find it more useful and profitable to study actual weather conditions and ground-water conditions in connection with the growth of plants, rather than to search for such remote influences as those possibly exerted by sun spots.—*C. A., jr.*

primary, the dark material fading somewhat between the two. The two together obviously form the winter tissue.

D, signifies a double ring and is used in cases where the second ring is not measured. This usually applies to cases where the interval is too small. Invariably the ring is traced for some distance to discover whether it is one double or two separate rings.

B, b, indicates that the ring is broad compared with adjacent rings in that part of the section. The small letter is generally used near the outside of the tree where the rings are narrow, and the capital letter near the center where the rings are all large. Rings thus marked have a well-defined age.

W, w, indicates a *wide* ring, distinguished from *broad* by having no well-defined inner edge. On the average broad and wide mean a winter ring having at least one-eighth of the total yearly growth.

f, indicates a faint ring, which character, like breadth and width, is estimated by comparison with the adjacent region.

The condition of the section is given as a whole. The line measured was always selected very carefully with reference to freedom from foreign irregularities in the rings, such as are caused by knots, and from cracks or breaks. Any unavoidable cracks are mentioned in the following remarks. [The Editor has been able to publish only those items that directly affect the accuracy of the measurements and averages that enter directly into the present discussion as to cycles of growth.-*C. A.*]

Notes on each individual section measured in Table 1.

Section I, yellow pine.—The scale, divided to millimeters, was read by estimation to tenths of a millimeter or hundredths of a centimeter. The scale readings increased from the outer bark inward. The reading of the first break in the bark was at 0.40 cm. The beginning of the red bark-ring is at 0.67 cm. The beginning of the last sap-ring is at 0.80 cm., hence this is taken as the beginning of the growth for the year 1903, and 0.13 cm., or 1.3 mm., as the total growth during 1903. The scale readings increase toward the center of the tree up to 5.57 cm. for 1874 when the scale was readjusted to read 0.02 cm. at this point. A similar readjustment took place at 1740, where 28.94 cm. A crack in the wood 0.25 cm. in width occurs at 1656 between the readings 19.92 and 20.17. The center of the section is at the reading 29.35 cm.

Section II, yellow pine.—A crack of 0.16 cm. occurs between 1650 (9.36 cm.) and 1651 (9.61 cm.) so that the annual growth foi 1651 is 0.09 cm. and not 0.25 cm. A crack of 0.02 cm. between 1644 (8.75 cm.) and 1643 (8.60 cm.) so that the growth for 1644 is 0.13 cm. and not 0.15 cm. A crack of 0.15 cm. between 1599 (1.85 cm.) and 1598 (1.48 cm.) at the center so that the growth for 1599 is 0.22 cm. and not 0.37 cm.

Section III, yellow pine.—The divided scale was readjusted at 1685 so that the readings 0.03 cm. and 27.27 cm. relate to the same ring. The center is at 1610 (12.90 cm.).

Section IV, yellow pine.—A crack of 0.01 cm. between 1684 (14.67 cm.) and 1683 (14.60 cm.) so that the growth for 1684 is 0.06 and not 0.07 cm. A crack of 0.02 cm. between 1680 and 1681 so that the growth for 1681 is 0.06 and not 0.08 cm. A crack between 1639 and 1640 so that the growth for 1640 is 0.05 and not 0.11 cm. A crack of 0.06 cm. between 1579 and 1580 so that the growth for 1580 is 0.08 and not 0.14 cm. The center is at 0.38 cm. for the year 1528.

Section V, blackjack (Quercus nigra).—A crack of 0.01 cm. between 1777 and 1778 so that the growth for 1778 is 0.09 and not 0.10 cm. The center is 7.00 for the year 1632.

Section VI, blackjack (Quercus nigra).—The center is at 31.30 cm. for the year 1691.

Section VII, yellow pine.—Measured on the north side of the center. At 1875 (36.35 cm.) blue rot begins and at 1807 (25.80 cm.) blue rot ends. The center is at 1702 (1.40 cm.). The total growth on the radii from the center to the 1906 ring is as follows: on the

North side, 39.5 cm.
East side, 42.0 cm.
South side, 37.9 cm.
West side, 37.2 cm.
Greatest, east ½ north, 42.2 cm.

Section VIII, yellow pine.—Was measured on the west side of the center, west side of the tree. At 1587 (1.68 cm.) a defect in the wood. The center is at 1577 (0.40 cm.). The total growth from the center to the 1906 ring is as follows:

North side, 50.0 cm., defective.
East side, 50.0 cm.
South side, 46.0 cm.
West side, 55.5 cm.
Greatest, west, 55.5 cm.

Section IX, [yellow pine?].—Crack at 1538 (0.05 cm.) so that the growth for 1538 is 0.09 and not 0.14 cm. Center at 1520 (25.95 cm.). The total growth from the center to the 1906 ring on the

North side, 37.0 cm.
East side, 34.0 cm.
South side, 38.0 cm.
West side, 42.0 cm.
Greatest, west-southwest, 43.5 cm.

Section X, yellow pine.—Measured onthe west-northwest side. The center is at 1584 (0.40 cm.). The growth from the center to the 1906 ring on the

North side, 43.0 cm.
East side, 41.0 cm.
South side, 40.0 cm.?
West side, 44.5 cm.
Greatest, west-southwest, 45.0 cm.

Section XI, yellow pine.—Measured due east of center. The center is at 1602 (0.70 cm.). The total growth on the

North side, 37.5 cm.
East side, 33.0 cm.
South side, 26.5 cm.
West side, 32.5 cm.
Greatest, northwest, 42.0 cm.

Section XII, yellow pine.—Measured on the northwest by north side. The center is at 1392 (1.10 cm.). The total growth on the

North side, 51.5 cm.
East side, 48.0 cm.
South side, 44.0 cm.
West side, 43.2 cm.

Section XIII, yellow pine.—Measured northeast by north from the center. The center is at 1412 (0.00 cm.). The total growth on the

North side, 49.3 cm.
East side, 42.0 cm.
South side, 38.0 cm.
West side, 41.3 cm.
Greatest, northeast, 50.0 cm.

Section XIV, yellow pine.—Measured west by south from the center. The center is at 1585 (38.10 cm.). The total growth on the

North side, 38.0 cm.
East side, 40.0 cm.
South side, broken.
West side, 35.0 cm.
Greatest, northeast, 42.0 cm.

Section XV, yellow pine.—Measured west ½ north. The center is at 1554 (60.50 cm.). The total growth on the

North side, 41.0 cm.
East side, 35.0 cm.
South side, 34.0 cm.
West side, 37.5 cm.
Greatest, east 5° south, 41.0 cm.

Section XVI, yellow pine.—Measured west by north. The center is at 1540 (1.10 cm.). The total growth on the

North side, 39.0 cm.
East side, 39.8 cm.
South side, 39.8 cm.
West side, 35.5 cm.
Greatest, east 5° south, 40.0 cm.

Section XVII, yellow pine.—Measured south. The center is at 1506 (26.10 cm.). The total growth is on the

North side, 42.0 cm.
East side, broken.
South side, 39.0 cm.
West side, 38.0 cm.
Greatest, north-northwest, 43.0 cm.

Section XVIII, yellow pine.—Measured north-northeast. The center is at 1692 (0.66 cm.). The total growth on the

North side, 42.6 cm.
East side, [46.5?] cm.
South side, 38.4 cm.
West side, 39.0 cm.
Greatest, north 5° west, 42.5 cm.?

Section XIX, yellow pine.—Measured northwest by north. The center is at 1666 (0.19 cm.). The total growth on the

North side, 37.7 cm.
East side, 31.0 defective.?
South side, 32.3 cm.
West side, 38.8 cm.
Greatest, northwest by north, 44.3 cm.

The readings for 1671-67 are uncertain, and in most of the sections the 6 or 7 lines nearest the center are uncertain [although no such ?? appear in the original manuscript tables].

Section XX, yellow pine.—Measured north. The center is at 1639 (1.70 cm.). The total growth on the

North side, 37.5 cm.
East side, 38.0 cm.?
South side, 34.5 cm.
West side, 34.5 cm.
Greatest, northeast, 43.5 cm.

Section XXI, yellow pine.—Measured north. The center is at 1643 (4.00 cm.). The total growth on the

North side, 40.3 cm.
East side, 44.0 cm.?
South side, 37.0 cm.
West side, 36.0 cm.
Greatest, northeast, 49.2 cm.

Section XXII, yellow pine.—Measured northwest. The center is at 1570 (0.10 cm.). The total growth on the

North side, 45.- cm. defective.
East side, 40.8 cm.
South side, 32.6 cm.
West side, 38.5 cm.
Greatest, north-northwest ½ west, 46.4 cm.

Section XXIII, yellow pine.—Measured north-northwest. From 1639 (16.00 cm.) to 1657 (16.95 cm.) the measurements were crossing a crack. The center is at 1521, (−0.05 cm.) and from 7.5 cm. to 11.0 cm. the circle of rings shows considerable irregularity. The total growth on the

North side, 41.0 cm.
East side, 42.0 cm.
South side, 44.0 cm.
West side, 47.7 cm.
Greatest, southwest by south, 48.2 cm.

Section XXIV, yellow pine.—Measured east 10° south, and readings were to 0.5 mm.; there was a crack of 0.2 cm. between 83.650 and 83.880 cm., so that the annual growth is 1.1 mm. and not 1.3 mm., but 1.3 mm. has been used in the computations. The center is at 65.050 cm. The total growth on the

North side, broken.
East side, 36.5 cm.
South side, 34.5 cm.
West side, 38.0 cm.
Greatest, west-southwest, 40.5 cm.

Section XXV, yellow pine.—Measured southwest. Center at 1574 (0.73 cm.). The total growth on the

North side, broken.
East side, broken.
South side, 31.0 cm.
West side, 32.0 cm.
Greatest, north (?), 40.0 cm. (?).

Table 1.—*Original scale readings, in centimeters, of Douglass's measurements of the Arizona pines.*

Year	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	Year.
1906	......	......	......	......	......	......	39.10	55.69	67.15	39.75	33.50	43.77	45.88	74.01	97,00	37.00	65.00	40.78	44.23	39.10	44.18	44.43	43.10	98.615	32.75	1906
05	......	......	......	......	......	......	38.95	.54	.12	.70	.46	.72	.84	73.94	.77	.81	64.94	.70	.12	.08	.10	.37	.09	.595	.72	05
04	......	......	......	......	......	......	.86	.40	.08	.64	.44	.68	.80	.87	.73	.78	.90	.64	43.98	.05	.03	.31	.06	.555	.68	04
03	0.80	28.10	15.93	29.40	29.06	00.16	.80	.29	.06	.58	.40	.63	.75	.84	.70	.74	.83	.58	.88	.00	43.95	.26	42.97	.530	.64	03
02	0.93	.01	.83	.36	.00	.30	.67	.15	.03	.53	.37	.56	.72	.78	.66	.72	.75	.52	.69	38.97	.88	.20	.85	.505	.58	02
01	1.01	27.94	.74	.35	28.96	.36	.63	.05	.01	.50	.34	.51	.68	.75	.63	.69	.70	.49	.59	.93	.81	.15	.78	.475	.54	01
1900	.13	.84	.66	.32	.93	.47	.51	54.94	66.98	.46	.30	.45	.65	.71	.62	.64	.65	.40	.41	.89	.74	.10	.70	.440	.50	1900
99	.21	.79	.57	.30	.90	.55	.39	.83	.96	.41	.26	.42	.62	.64	.58	.59	.61	.34	.30	.84	.69	.05	.66	.380	.46	99
8	.34	.73	.50	.27	.83	.63	.31	.70	.93	.36	.23	.38	.56	.58	.56	.52	.55	.27	.21	.78	.62	43.99	.60	.320	.40	8
7	.53	.66	.39	.24	.79	.75	.15	.54	.88	.29	.20	.30	.52	.49	.53	.48	.51	.18	.06	.71	.54	.92	.57	.230	.36	7
6	.70	.58	.30	.21	.74	.87	.06	.41	.85	.21	.16	.25	.49	.41	.50	.41	.47	.06	42.95	.65	.48	.86	.54	.160	.31	6
5	.85	.52	.20	.19	.68	.97	37.91	.28	.81	.15	.14	.18	.45	.35	.48	.34	.43	39.94	.80	.60	.43	.79	.49	.095	.26	5
4	2.09	.44	.10	.15	.64	1.05	.85	.16	.76	.10	.12	.14	.42	.27	.45	.28	.40	.84	.70	.55	.35	.75	.46	.050	.22	4
3	.30	.36	.00	.11	.56	.14	.76	.05	.71	.04	.09	.07	.38	.21	.42	.23	.35	.73	.55	.49	.30	.72	.43	.000	.17	3
2	56	.26	14.90	.06	.50	.23	.63	53.96	.67	.00	.06	.03	.35	.14	.38	.17	.30	.65	.46	.45	.25	.67	.39	97.970	.13	2
1	.86	.18	.81	.00	.45	.29	.54	.88	.63	38.94	.03	42.98	.30	.07	.36	.12	.25	.59	.36	.42	.20	.64	.33	.940	.08	1
1890	3.10	.13	.74	28.96	.38	.36	.45	.77	.56	.88	32.98	.94	.25	.01	.33	.08	.20	.52	.26	.38	.16	.59	.28	.890	.03	1890
89	.32	.06	.64	.93	.34	.50	.37	.66	.52	.81	.96	.88	.20	72.94	.30	.03	.16	.41	.12	.31	.11	.54	.22	.840	31.99	89
8	.53	.02	.57	.89	.29	.59	.28	.54	.49	.76	.94	.84	.15	.87	.28	36.98	.12	.32	.02	.29	.05	.48	.11	.785	.96	8
7	.77	26.97	.50	.86	.25	.66	.22	.43	.46	.70	.92	.79	.11	.81	.26	.94	.09	.23	41.90	.23	.00	.43	.03	.740	.92	7
6	.98	.93	.44	.83	.21	.74	.16	.34	.43	.66	.90	.74	.07	.75	.24	.89	.05	.18	.83	.16	42.96	.40	41.93	.700	.87	6
5	4.16	.87	.40	.81	.17	.82	.09	.25	.39	.62	.84	.70	.03	.69	.22	.84	.01	.13	.75	.11	.93	.36	.83	.670	.83	5
4	.38	.82	.35	.77	.14	.94	.04	.14	.34	.57	.82	.65	44.98	.63	.20	.79	63.98	.06	.65	.06	.87	.32	.76	.640	.78	4
3	.50	.77	.28	.75	.10	2.00	36.99	.05	.30	.54	.80	.00	.94	.56	.18	.74	.95	38.98	.56	37.97	.82	.29	.69	.600	.75	3
2	.60	.75	.25	.74	.06	.09	.93	52.96	.26	.49	.75	.55	.90	.50	.16	.70	.93	.90	.50	.92	.77	.26	.59	.560	.70	2
1	.74	.73	.20	.73	.05	.15	.87	.90	.21	.44	.72	.51	.85	.46	.14	.66	.90	.83	.42	.89	.70	.24	.47	.520	.66	1
1880	.88	.68	.17	.72	.04	.24	.83	.80	.11	.40	.67	.45	.82	.42	.10	.63	.88	.73	.32	.85	.65	.22	.40	.490	.64	1880
79	.98	.66	.13	.70	.03	.29	.78	.73	.06	.37	.62	.38	.80	.39	.08	.59	.85	.63	.27	.79	.55	.19	.25	.470	.60	79
8	5.09	.60	.08	.67	.00	.33	.70	.64	65.99	.34	.57	.35	.74	.37	.06	.55	.82	.58	.21	.75	.50	.15	.14	.440	.56	8
7	.25	.55	.05	.65	27.97	.39	.59	.50	.93	.29	.54	.28	.70	.31	.03	.52	.79	.45	.10	.70	.44	.10	.00	.400	.52	7
6	.37	.50	.00	.63	.93	.44	.50	.40	.84	.24	.50	.25	.66	.24	96.99	.47	.75	.37	.04	.63	.39	.03	40.90	.350	.49	6
5	.47	.44	13.95	.61	.90	.50	.35	.29	.78	.20	.45	.18	.62	.19	.96	.43	.70	.30	40.96	.59	.33	.00	.80	.285	.46	5
4	5.57 0.02	.34	.90	.58	.87	.56	.23	.14	.66	.11	.42	.13	.58	.12	.94	.38	.66	.19	.85	.54	.24	42.95	.65	.225	.41	4
3	.10	.24	.82	.56	.85	.66	.15	51.94	.61	.04	.36	.02	.54	.00	.90	.34	.61	.04	.69	.49	.18	.87	.54	.160	.37	3
2	.22	.15	.74	.54	.81	.73	.03	.85	.56	37.98	.32	41.96	.49	71.93	.87	.32	.56	37.95	.60	.45	.11	.82	.45	.115	.35	2
1	.35	.07	.64	.51	.77	.82	35.09	.70	.53	.92	.26	.88	.44	.87	.84	.29	.48	.83	.52	.40	.06	.77	.30	.050	.28	1
1870	.52	25.99	.53	.48	.75	.91	.72	.55	.48	.83	.22	.80	.36	.80	.82	.26	.45	.69	.40	.35	41.97	.73	.22	.000	.24	1870
69	.76	.89	.39	.42	.70	3.12	.59	.40	.45	.75	.16	.74	.30	.75	.79	.22	.38	.56	.27	.30	.92	.69	.12	96.950	.20	69
8	1.00	.82	.31	.39	.64	.17	.40	.30	.39	.69	.12	.65	.24	.63	.76	.19	.35	.46	.15	.24	.83	.65	.02	.915	.17	8
7	.17	.74	.21	.35	.58	.41	.30	.07	.35	.56	.05	.58	.19	.55	.73	.15	.28	.35	39.95	.19	.77	.56	39.92	.850	.15	7
6	.37	.66	.16	.33	.53	.54	.17	50.94	.27	.48	.01	.50	.10	.47	.69	.11	.25	.25	.85	.13	.69	.52	.81	.780	.12	6
5	.50	.57	.10	.31	.49	.68	.03	.77	.20	.40	31.96	.42	.05	.43	.65	.07	.20	.11	.71	.08	.61	.47	.65	.725	.07	5
4	.62	.51	.04	.28	.46	.80	34.94	.64	.13	.33	.93	.35	43.99	.39	.62	.03	.17	.00	.63	.03	.55	.42	.51	.680	.03	4
3	.78	.45	12.96	.24	.43	.89	.85	.50	.08	.27	.89	.30	.94	.34	.58	35.97	.12	36.92	.53	36.96	.48	.38	.37	.645	30.97	3
2	.95	.39	.90	.22	.37	.98	.63	.40	.00	.21	.87	.25	.87	.26	.55	.92	.07	.85	.45	.90	.40	.34	.28	.600	.92	2
1	2.08	.35	.82	.16	.34	4.10	.51	.25	64.92	.15	.84	.18	.83	.19	.50	.85	.00	.74	.35	.81	.32	.25	.18	.550	.85	1
1860	.23	.28	.77	.14	.28	.21	.33	.14	.84	.12	.79	.13	.76	.13	.47	.77	62.93	.66	.24	.74	.25	.18	.10	.485	.82	1860
59	.40	.20	.69	.10	.24	.32	.16	49.94	.77	.00	.74	.06	.70	.08	.42	.70	.89	.56	.10	.70	.15	.10	38.99	.410	.77	59
8	.48	.16	.61	.08	.16	.44	.00	.78	.71	36.94	.70	40.99	.64	.02	.36	.64	.83	.44	.01	.64	.05	.03	.96	.355	.73	8
7	.66	.08	.52	.03	.12	.67	33.90	.64	.65	.87	.67	.94	.57	70.98	.30	.59	.76	.30	38.86	.59	40.96	41.95	.90	.300	.66	7
6	.90	24.99	.44	27.99	.08	.80	.78	.48	.59	.81	.57	.87	.52	.92	.28	.53	.70	.18	.75	.53	.89	.90	.86	.250	.61	6
5	3.12	.90	.35	.94	.00	5.00	.67	.28	.53	.74	.50	.81	.45	.87	.23	.47	.65	.07	.65	.48	.79	.83	.80	.190	.53	5
4	.38	.80	.29	.90	26.90	.14	.49	.10	.48	.68	.45	.75	.38	.79	.20	.42	.56	35.96	.53	.43	.69	.75	.73	.120	.50	4
3	.59	.69	.22	.86	.81	.35	.29	48.87	.46	.60	.38	.66	.32	.72	.16	.36	.47	.82	.39	.37	.59	.68	.70	.045	.43	3
2	.72	.59	.17	.84	.72	.53	.10	.70	.43	.50	.28	.59	.26	.66	.13	.36	.44	.70	.25	.31	.49	.60	.64	95.980	.36	2
1	.84	.58	.13	.78	.67	.74	32.98	.53	.40	.39	.20	.53	.23	.62	.11	.24	.36	.55	.10	.27	.40	.51	.54	.930	.29	1
1850	.96	.45	.09	.74	.59	.84	.83	.40	.35	.32	.15	.48	.18	.57	.08	.18	.31	.47	.01	.20	.33	.46	.43	.900	.26	1850
49	4.06	.32	.05	.68	.50	6.01	.70	.23	.30	.27	.07	.43	.15	.54	.05	.13	.25	.40	37.89	.15	.25	.41	.34	.855	.22	49
8	.13	.26	.02	.65	.44	.21	.55	.05	.25	.22	30.95	.37	.10	.48	.00	.07	.22	.29	.75	.11	.17	.34	.25	.830	.17	8
7	.24	.16	11.99	.63	.40	.35	.44	47.92	.20	.15	.85	.31	.05	.44	95.98	.02	.18	.17	.60	.07	.10	.25	.15	.790	.11	7
6	.36	.11	.95	.57	.36	.41	.32	.85	.15	.11	.75	.25	42.99	.40	.96	34.95	.14	.08	.54	.02	.05	.20	.06	.765	.06	6
5	.51	.06	.92	.54	.30	.51	.25	.74	.09	.06	.69	.21	.94	.35	.92	.89	.10	.00	.43	35.98	39.97	.14	37.99	.745	.02	5
4	.66	23.98	.89	.50	.24	.57	.10	.65	.03	.00	.50	.16	.92	.32	.88	.81	.05	34.91	.35	.96	.90	.09	.89	.700	29.98	4
3	.80	.92	.86	.46	.19	.68	.01	.55	63.97	35.95	.40	.10	.87	.28	.85	.76	.02	.80	.24	.90	.82	.03	.71	.660	.93	3
2	.95	.85	.83	.40	.14	.75	31.91	.44	.92	.89	.25	.04	.82	.25	.82	.71	61.99	.72	.09	.88	.73	40.97	.55	.645	.89	2
1	5.09	.76	.80	.34	.06	.86	.83	.36	.85	.84	.15	.00	.78	.18	.79	.66	.94	.67	36.99	.84	.65	.93	.36	.565	.86	1
1840	.26	.70	.77	.30	.00	.93	.75	.28	.80	.79	.05	39.96	.75	.13	.75	.60	.87	.61	.90	.77	.60	.87	.31	.530	.83	1840
39	.44	.62	.74	.25	25.94	7.01	.59	.14	.75	.73	29.88	.91	.71	.05	.73	.55	.83	.53	36.79	.71	.53	.82	.18	.485	.78	39
8	.60	.54	.72	.18	.87	.12	.49	46.96	.68	.65	.79	.84	.67	69.98	.68	.47	.78	.42	.64	.66	.43	.74	.02	.440	.74	8
7	.75	.45	.68	.13	.82	.20	.35	.84	.59	.59	.67	.80	.62	.92	.66	.42	.70	.32	.50	.61	.35	.68	36.85	.390	.68	7
6	.90	.36	.65	.06	.74	.29	.10	.74	.50	.53	.46	.75	.58	.84	.64	.35	.63	.23	.36	.58	.25	.60	.74	.335	.66	6
5	6.01	.28	.62	.00	.68	.43	30.95	.61	.45	.45	.23	.68	.54	.77	.61	.29	.57	.10	.18	.54	.15	.54	.64	.285	.60	5
4	.20	.23	.56	26.93	.61	.60	.75	.48	.35	.38	.05	.63	.50	.69	.57	.24	.51	.00	.04	.49	.07	.50	.58	.230	.54	4
3	.45	.18	.53	.86	.54	.75	.55	.34	.30	.31	28.90	.56	.45	.62	.55	.18	.45	33.88	35.88	.43	.00	.45	.47	.180	.52	3
2	.60	.11	.49	.82	.48	8.00	.34	.19	.24	.23	.70	.50	.40	.54	.52	.11	.36	.78	.70	.39	38.94	.36	.40	.140	.46	2
1	.80	.03	.44	.76	.41	.23	.15	.05	.19	.16	.53	.44	.36	.49	.48	.08	.29	.63	.54	.35	.87	.31	.30	.090	.41	1

TABLE I.—*Original scale readings, in centimeters, of Douglass's measurements, etc.*—Continued.

Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	Year.
1830	6.96	22.99	11.40	26.66	25.36	8.40	29.95	45.90	63.13	35.09	28.43	39.38	42.34	69.45	95.45	34.02	61.26	33.50	35.40	35.32	38.80	40.20	36.24	95.060	29.35	1830
29	7.12	.94	.37	.62	.30	.62	.74	.75	.08	.02	.31	.30	.32	.37	.42	.00	.22	.34	.16	.28	.72	.13	.18	.010	.32	29
8	.35	.87	.35	.56	.25	.73	.64	.68	62.99	34.98	.20	.27	.30	.31	.39	33.95	.18	.25	.08	.25	.68	.05	.08	94.970	.28	8
7	.55	.82	.32	.49	.17	.90	.40	.55	.95	.90	.10	.22	.26	.26	.36	.90	.14	.15	34.90	.23	.61	39.97	.00	.925	.24	7
6	.75	.79	.26	.44	.12	9.01	.26	.45	.88	.83	.00	.17	.24	.20	.32	.84	.11	.05	.72	.20	.55	.89	35.95	.900	.19	6
5	.94	.76	.23	.39	.05	.16	.10	.29	.82	.76	27.89	.10	.20	.16	.30	.79	.08	32.95	.49	.16	.50	.82	.92	.870	.16	5
4	8.06	.73	.20	.36	.00	.27	28.99	.16	.75	.72	.78	.06	.13	.13	.27	.73	.04	.90	.31	.14	.45	.75	.76	.855	.12	4
3	.18	.70	.15	.30	24.96	.35	.79	.06	.68	.67	.69	.02	.08	.06	.25	.70	60.98	.81	.18	.11	.40	.71	.64	.805	.09	3
2	.33	.67	.10	.23	.92	43	.60	.00	.60	.63	.57	38.98	.04	.00	.22	D .64	.96	.73	.09	.09	.37	.62	.52	.770	.04	2
1	.44	.65	.06	.16	.87	.47	.45	44.90	.50	.56	.49	.93	.00	68.96	.18	.62	.91	.69	.03	.04	.30	.55	.41	.760	.00	1
1820	.56	.62	.01	.10	.84	.56	.34	.85	.43	.51	.38	.88	41.95	.93	.15	.58	.89	.60	33.87	.01	.25	.51	.34	.740	28.94	1820
19	.68	.60	10.96	.05	.79	.60	.25	.76	.31	.44	.28	.82	.90	.85	.12	.56	.85	.54	.76	34.98	.19	.46	.26	.705	.87	19
8	.75	.56	.93	25.97	.73	.72	.00	.72	.20	.41	.20	.80	.84	.78	.10	.51	.80	.39	.56	.95	.16	.42	10	.655	.83	8
7	.92	.52	.89	.92	.68	.76	27.70	.65	.10	.35	.10	.76	.77	.74	.05	.46	.77	.26	.45	.90	.12	.39	34.96	.605	.75	7
6	9.06	.49	.84	.85	.64	.80	.60	.54	.00	.28	26.98	.72	73	.71	.00	.42	.75	.14	.36	.86	.05	.36	.89	.550	.70	6
5	.31	.45	.80	.76	.59	.90	.40	.44	61.92	.22	.92	.66	.70	.63	94.92	.34	.72	31.90	.22	.83	37.98	.34	.75	.495	.65	5
4	.56	.40	.74	.64	.51	10.04	.15	.38	.83	.16	.76	.63	.64	.50	.86	.29	.65	.83	.06	.78	.90	.29	.62	.445	.60	4
3	.85	.35	.70	.52	.42	.18	26.96	.33	.73	.14	.62	.60	.58	.39	.80	.22	.61	.76	32.93	.71	.85	.21	.55	.390	.55	3
2	10.15	.31	.64	.40	.33	.26	.80	.24	.67	.07	.50	.58	.55	.26	.76	.16	.57	.65	.84	.69	.78	.16	.44	.350	.50	2
1	.44	.24	.58	.30	.24	.45	.69	.11	.63	33.98	.32	.52	.51	.19	.69	.10	.54	.41	.71	.67	.71	.09	.34	.290	.45	1
1810	.67	.16	.52	.18	.18	.69	.55	.00	.53	.91	.14	.47	.46	.13	.64	.05	.50	.31	.50	.64	.63	.03	.29	.235	.40	1810
09	10.86	.10	.49	.09	.13	.85	.25	43.90	.48	.82	.00	.40	.43	.04	.60	.00	.47	.15	.30	.59	.55	.00	.16	.200	.34	09
08	11.03	.03	.43	24.98	.06	11.04	.00	.86	.43	.75	25.90	.35	.37	67.96	.55	32.92	.43	.00	.12	.54	.48	38.94	.06	.150	.31	08
07	.27	21.97	.36	.86	23.99	.20	25.80	.69	.33	.70	.77	.31	.31	.89	.50	.85	.39	30.86	31.90	.51	.40	.87	33.95	.105	.27	07
06	.48	.92	.33	.75	.94	.34	.65	.59	.29	.63	.70	.26	.26	.83	.46	.80	.36	.72	.74	.48	.34	.82	.79	.080	.22	06
05	.71	.83	.27	.62	.87	.53	.38	.46	.20	.56	.62	.21	.20	.75	.42	.75	.34	.52	.57	.42	.25	.78	.66	.045	.18	05
04	.97	.75	.20	.49	.82	.71	.20	.35	.13	.51	.50	.16	.15	.71	.36	.68	.32	.39	.42	.37	.19	.71	.51	.005	.13	04
03	12.20	.66	.17	.40	.78	.86	.00	.26	.03	.45	.41	.13	.08	.66	.33	.63	.29	.25	.25	.34	.11	.67	.40	93.955	.08	03
02	38	.60	.13	.30	.74	12.05	24.73	.15	60.95	.37	.33	.06	40.99	.56	.29	.58	.27	.10	.14	.32	.02	.60	.30	.905	.04	02
01	.54	.53	.05	.18	.65	.25	.55	.09	.84	.32	.16	.02	.90	.50	.26	.52	.21	.00	30.99	.27	36.95	.50	.24	.860	27.98	01
1800	.66	.49	.02	.09	.60	.35	.28	42.99	.75	.27	.00	37.97	.84	.44	.20	.48	.17	29.80	.90	.24	.85	.45	.18	.820	.92	1800
1799	.91	.43	9.94	23.98	.53	.50	.12	.84	.67	.18	24.90	.92	.76	.38	.15	.41	.13	.55	.75	.22	.75	.39	.08	.750	.87	1799
8	13.20	.34	.86	.86	.43	.75	23.88	.72	.62	.11	.78	.89	.70	.30	.07	.36	.09	.38	.56	.19	.68	.31	.00	.700	.82	8
7	.48	.27	.79	.76	.35	.94	.57	.57	.54	.03	.69	.86	.65	.21	.00	.30	.03	.21	.45	.16	.60	.25	32.91	.655	.77	7
6	.74	.19	.74	.65	.28	13.13	.28	.44	.45	32.97	.60	.83	.60	.11	93.96	.23	59.98	.06	.30	.13	.51	.19	.75	.610	.75	6
5	14.04	.10	.64	.49	.19	.28	.12	.32	.32	.91	.50	.77	.52	.04	.93	.16	.93	28.94	.15	.09	.43	.10	.63	.580	.71	5
4	.44	.00	.57	.36	.12	.50	22.96	.22	.24	.82	.38	.72	.45	.00	.90	.10	.90	.80	.01	33.95	.34	.04	.54	.555	.65	4
3	.79	20.89	.50	.25	.05	.72	.83	.10	.18	.70	.25	.65	.41	66.95	.86	.05	.86	.60	29.80	.90	.25	.00	.49	.510	.63	3
2	15.00	.77	.45	.09	22.98	14.02	.70	.02	.04	.64	.15	.60	.34	.91	.82	.00	.82	.50	.57	.85	.20	37.95	.43	.460	.59	2
1	.20	.66	.40	22.95	.94	.25	.55	41.96	59.93	.58	.05	.55	.29	.87	.79	31.97	.78	.40	.43	.78	.16	.92	.36	.445	.55	1
1790	.31	.58	.36	.83	.90	.45	.25	.83	.82	.51	.00	.51	.25	.79	.76	.91	.73	.27	.30	.72	.11	.87	.25	.400	.52	1790
89	.50	.49	.29	.69	.86	.70	.05	.83	.77	.46	23.88	.46	.20	.76	.72	.85	.71	.16	.06	.64	.07	.80	.18	.355	.46	89
8	.77	.42	.25	.56	.80	.84	21.93	.72	.71	.39	.78	.42	.17	.73	.69	.81	.68	.05	28.95	.55	.02	.77	.08	.310	.44	8
7	16.05	.34	.22	.46	.76	15.03	.63	.59	.66	.30	.70	.35	.13	.65	.67	.76	.61	27.90	.80	.49	35.95	.73	31.99	.300	.41	7
6	.28	.26	.16	.28	.66	.20	.43	.53	.58	.26	.60	.30	.08	.61	.63	.69	.57	.75	.55	.40	.91	.62	.93	.260	.40	6
5	.64	.20	.13	.11	.60	.40	.34	.45	.51	.20	.48	.27	.04	.58	.61	.63	.55	.60	.38	.35	.84	.56	.80	.250	.37	3
4	.96	.14	.11	.00	.55	.59	.19	.26	.46	.09	.34	.20	39.95	.55	.57	.60	.53	.36	.25	.27	.75	.53	.70	.225	.33	4
3	17.13	.04	.08	21.90	.48	.85	.05	.15	.40	.00	.22	.15	.85	.52	.54	.54	.51	.22	.63	.23	.66	.47	.60	.190	.29	3
2	.39	19.96	.06	.80	.41	16.10	20.95	.10	.33	31.95	.13	.11	.80	.49	.50	.50	.47	.15	27.85	.18	.62	.43	.52	.145	.23	2
1	.58	.85	.04	.70	.34	.22	.85	.00	.27	.89	.02	.06	.75	.44	.45	.45	.44	.00	.77	.15	.56	.38	.43	.095	.16	1
1780	.78	.79	.00	.60	.28	.41	.65	40.94	.19	.84	22.93	.03	.67	.40	.39	.40	.41	26.91	.64	.10	.51	.33	.36	.050	.10	1780
79	18.00	.73	8.96	.45	.15	.55	.51	.83	.11	.79	.83	36.99	.60	.36	.34	.34	.35	.81	.49	.04	.46	.29	.30	.000	.06	79
8	.25	.66	.90	.33	.05	.70	.33	.75	.05	.74	.74	.95	.52	.34	.31	.28	.30	.67	.38	32.99	.40	.20	.20	92.940	.00	8
7	.48	.56	.84	.21	21.95	.80	.15	.66	58.95	.65	.65	.89	.45	.30	.26	.23	.25	.48	.24	.93	.33	.11	.07	.890	26.95	7
6	.65	.47	.77	.11	.89	17.00	.01	.56	.83	.59	.53	.82	.39	.24	.21	.17	.20	.24	.05	.82	.26	.06	30.95	.830	.90	6
5	.77	.39	.72	.04	.86	.18	19.80	.45	.70	.50	.35	.75	.30	.17	.15	.14	.15	.05	26.81	.72	.20	.03	.79	.770	.83	5
4	.91	.30	.65	20.94	.80	.34	.53	.35	.53	.40	.30	.70	.19	.12	.10	.06	.08	25.85	.60	.64	.13	36.95	.67	.715	.74	4
3	19.15	.20	.56	.64	.74	.56	.38	.26	.44	.34	.15	.65	.10	.05	.05	.04	.04	.71	.40	.60	[illegible]	.89	.52	.645	.67	3
2	.41	.09	.48	.71	.68	.74	18.96	.14	.35	.25	.09	.58	38.98	65.95	.00	30.93	58.98	.64	.21	.54	34.95	.81	.39	.595	.22	2
1	.66	18.99	.39	.61	.65	.93	.60	39.97	.26	.15	.00	.52	.89	.88	92.93	.85	.90	.42	.00	.46	.86	.75	.22	.530	.54	1
1770	.87	.90	.36	.53	.61	18.09	.26	.85	.19	.09	21.93	.45	.80	.80	.85	.79	.84	.18	.81	.39	.76	.70	.12	.450	.48	1770
69	20.08	.83	.31	.39	.55	.23	17.90	.70	.10	30.99	.86	.39	.70	.70	.77	.73	.76	.02	.61	.30	.68	.63	.06	.400	.40	69
8	.33	.75	.20	.28	.50	.42	.62	.54	.00	.91	.76	.32	.63	.63	.72	.66	.68	24.80	.40	.22	.60	.56	29.96	.345	.34	8
7	.56	.66	.10	.14	.40	.68	.32	.35	57.94	.85	.69	.23	.56	.55	.66	.58	.61	.61	.20	.19	.51	.48	.86	.300	.28	7
6	.80	.59	7.99	19.95	.29	.96	.10	.19	.89	.76	.53	.15	.45	.45	.58	.47	.57	.33	24.93	.15	.39	.40	.76	.250	.22	6
5	21.15	.48	.88	.87	.19	19.16	16.85	39.00	.84	.67	.45	.08	.37	.36	.52	.39	.51	.04	.65	.11	.30	.33	.65	.220	.15	5
4	.45	.37	.76	.80	.05	.43	.58	38.80	.80	.55	.30	35.97	.32	.27	.45	.29	.46	23.70	.36	.05	.18	.23	.56	.150	.09	4
3	.80	.26	.64	.66	20.90	.73	.38	.64	.73	.50	.10	.90	.25	.18	.37	.23	.42	.40	.03	.00	.09	.12	.44	.100	.06	3
2	22.13	.15	.52	.55	.80	.90	.07	.46	.67	.36	20.93	.83	.19	.13	.31	.15	.36	.20	23.80	31.95	33.97	.05	.26	.050	.01	2
1	.48	.03	.44	.44	.70	20.05	15.70	.33	.60	.23	.79	.74	.11	.08	.27	.08	.30	22.95	.50	.90	.85	35.99	.12	.030	25.94	1
1760	.88	17.95	.36	.35	.51	.25	.42	.19	.48	.09	.60	.68	.04	.04	.23	.00	.28	.70	.23	.84	.75	.90	.02	91.990	.88	1760
59	23.32	.88	.26	.22	.36	.46	.23	.05	.35	.01	.49	.63	37.97	.00	.18	29.91	.24	.47	.03	.75	.67	.80	28.89	.950	.81	59
8	.73	.80	.22	.10	.26	.66	.07	37.86	.22	29.86	.39	.57	.90	64.96	.13	.86	.17	.20	22.80	.66	.58	.76	.75	.910	.76	8
7	24.04	.73	.16	.04	.16	.86	14.83	.71	.10	.78	.26	.50	.85	.94	.08	.78	.10	21.92	.60	.56	.50	.70	.63	.860	.66	7
6	.34	.69	.13	18.99	.01	21.05	.50	.64	.03	.70	.19	.46	.77	.89	.03	.71	.03	.56	.42	.50	.42	.59	.51	.840	.56	6
5	.61	.65	.09	.89	19.89	.23	.32	.50	56.94	.59	.10	.41	.66	.84	91.97	.63	57.95	.40	.33	.34	.32	.50	.40	.800	.49	5
4	.85	.60	.06	.82	.84	.36	.18	.36	.86	.45	.03	.37	.60	.76	.95	.55	.87	.20	.15	.15	.20	.35	.33	.740	.42	4
3	25.05	.56	.04	.77	.68	.46	.08	.23	.80	.35	19.90	.33	.54	.73	.89	.48	.84	20.95	21.94	.06	.10	.25	.21	.690	.36	3
2	.28	.48	6.98	.70	.51	.64	13.90	.17	.70	.17	.85	.28	.45	.63	.81	.39	.78	.72	.71	30.94	.00	.13	.15	.645	.29	2
1	.50	.40	.90	.61	.36	.86	.69	.05	.63	.05	.73	.24	.40	.50	.76	.29	.69	.58	.60	.85	32.86	.07	.02	.595	.21	1
1750	80	.32	.80	.54	.30	22.02	.30	36.90	.56	28.89	.60	.20	.30	.43	.71	.20	.63	.20	.44	.76	.72	34.93	27.92	.535	.13	1750
49	.94	.26	.76	.48	.24	.10	.15	.72	.53	.82	.57	.16	.20	.35	.65	.10	.57	19.85	.19	.67	.63	.87	.83	.470	.06	49
8	26.21	.21	.65	.39	.03	.25	12.86	.65	.43	.72	.50	.11	.14	.25	.60	.00	.50	.45	20.90	.60	.58	.75	.70	.435	.02	8
7	.47	.16	.51	.26	18.75	.50	.53	.43	.32	.57	.45	.05	.02	.16	.53	28.90	.45	.35	.75	.49	.37	.55	.59	.400	24.93	7
6		.09	.44	.15	.50	.69	.22	.30	.26	.44	.40	.00	36.92	.06	.46	.79	.40	.20	.47	.39	.26	.45	.49	.340	.88	6
5	27.15	.05	.33	.04	.25	.90	11.98	.02	.17	.30	.34	34.95	.82	63.95	.40	.69	.35	18.64	.12	.24	.16	.38	.43	.305	.82	5
4	.54	16.98	.23	17.93	.04	23.10	.73	35.77	.10	.19	.30	.89	.75	.90	.35	.60	.31	.34	19.85	.16	.05	.26	.38	.240	.77	4
3	.87	.94	.15	.84	17.79	.25	.57	.50	.04	.02	.10	.81	.65	.82	.32	.53	.25	.08	.62	29.90	31.98	.16	.29	.160	.73	3
2	28.26	.87	.07	.76	.58	.42	.25	.28	.00	27.85	18.94	.74	.55	.76	.25	.43	.22	17.78	.34	.69	.85	.10	.10	.110	.68	2
1	.64	.80	5.96	.62	.41	.60	.10	.10	55.90	.70	.80	.69	.45	.66	.20	.37	.16	.53	.05	.54	.75	33.99	26.97	.060	.64	1
1740	.94 / 00.10	.74	.89	.51	.26	.72	10.71	34.90	.81	.58	.65	.64	.35	.64	.17	.28	.09	.25	18.71	.40	.69	.92	.80	.020	.58	1740
39	.43	.66	.77	.39	.05	.97	.50	.78	.67	.43	.53	.55	.26	.50	.13	.15	.07	.05	.45	.35	.61	.80	.63	90.970	.56	39
8	.64	.62	.67	.32	16.92	24.10	.15	.55	.51	.31	.39	.49	.20	.41	.09	.03	.03	16.78	.20	.05	.53	.66	.52	.935	.50	8
7	.83	.55	.57	.21	.75	.30	9.60	.40	.43	.22	.25	.42	.14	.33	.02	27.93	56.99	.40	17.89	28.89	.44	.57	.41	.870	.43	7
6	.98	.52	.50	.14	.68	.37	.25	.26	.30	.01	.14	.37	.09	.26	90.99	.85	.96	.06	.60	.75	.35	.50	.21	.820	.27	6
5	1.32	.46	.44	.04	.43	.64	8.95	.20	.23	26.85	18.00	.30	35.87	.18	.95	.73	.94	15.66	.33	.52	.20	.45	.05	.690	.12	5

Table I.—*Original scale readings, in centimeters, of Douglass's measurements, etc.*—Continued.

Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	Year.
1734	1.58	16.41	5.37	16.96	16.28	24.82	8.65	32.03	55.15	26.69	17.82	34.25	35.66	63.14	90.90	27.63	56.88	15.47	17.18	28.30	31.02	33.28	25.86	90.560	23.99	1734
3	.83	.35	.32	.90	.09	25.07	.45	33.91	.00	.65	.70	.20	.54	.09	.80	.55	.84	.19	16.95	.15	30.85	.20	.70	.460	.85	3
2	2.08	.31	.26	.85	15.96	.23	7.95	.75	54.85	.39	.60	.15	.44	.00	.71	.45	.74	14.90	.67	.00	.74	.10	.59	.380	.76	2
1	.37	.26	.18	.80	.80	.39	.46	.61	.72	.28	.50	.07	.32	62.89	.65	.35	.63	.54	.40	27.80	.54	.01	.45	.310	.69	1
1730	.54	.22	.14	.76	.70	.50	6.97	.45	.62	.16	.38	.04	.21	.81	.58	.25	.56	.24	.20	.62	.43	32.80	.33	.250	.57	1730
29	.74	.15	.06	.71	.60	.60	.47	.37	.53	.04	.26	33.99	.09	.76	.53	.11	.47	13.82	15.95	.40	.30	.56	.20	.150	.49	29
8	.99	.09	.00	.67	.53	.72	5.98	.26	.40	25.82	.16	.95	34.97	.68	.47	26.98	.41	.66	.78	.20	.15	.36	.04	.090	.38	8
7	3.36	15.96	4.94	.60	.35	.90	.62	.14	.25	.54	.01	.86	.81	.60	.40	.85	.37	.48	.60	.00	.02	.19	24.92	89.960	.29	7
6	.70	.87	.86	.55	.22	26.04	.36	32.95	.05	.37	16.83	.77	.70	.50	.33	.74	.29	.23	.40	26.84	29.85	.07	.78	.890	.20	6
5	.96	.79	.80	.50	.10	.14	.05	.80	53.90	.13	.70	.72	.55	.39	.23	.56	.24	12.73	14.97	.60	.69	31.97	.63	.810	.14	5
4	4.26	.70	.71	.47	14.99	.30	4.61	.65	.79	24.95	.60	.65	.42	.30	.16	.45	.12	.05	.55	.35	.49	.80	.49	.740	.06	4
3	.47	.63	.64	.45	.91	.46	.29	.44	.65	.74	.38	.58	.32	.19	.10	.28	.07	11.68	.30	.17	.34	.67	.39	.650	22.97	3
2	.69	.54	.56	.42	.85	.75	3.94	.30	.50	.54	.17	.51	.21	.11	.05	.14	.01	.15	.00	25.92	.13	.48	.21	.550	.90	2
1	.95	.44	.46	.38	.76	.95	.77	.12	.37	.35	15.98	.43	.12	.02	89.98	25.99	55.96	10.70	13.70	.72	28.94	.34	.03	.470	.85	1
1720	5.17	.36	.36	.36	.64	27.11	.59	31.90	.27	.13	.88	.36	.04	61.93	.93	.84	.91	.23	.40	.57	.78	.20	23.86	.400	.75	1720
19	.40	.28	.25	.32	.46	.29	.40	.74	.06	23.95	.70	.28	33.92	.80	.86	.66	.86	9.70	.07	.39	.57	.09	.72	.285	.66	19
8	.60	.19	.17	.30	.38	.40	.25	.50	52.86	.77	.58	.20	.82	.70	.80	.50	.83	.35	12.82	.12	.33	30.96	.56	.170	.60	8
7	.85	.13	.10	.26	.29	.55	.11	.36	.68	.63	.45	.12	.74	.60	.71	.32	.79	8.92	.45	24.85	.08	.80	.40	.110	.55	7
6	6.11	.05	.03	.24	.24	.66	.00	.24	.54	.44	.33	.05	.65	.52	.65	.23	.75	.59	.18	.61	27.80	.66	.20	.040	.40	6
5	.37	14.97	3.95	.19	.13	.81	2.85	.08	.39	.27	.12	.00	.49	.40	.61	.10	.70	.19	11.90	.40	.57	.55	.00	88.930	.35	5
4	.64	.85	.88	.16	.02	.95	.68	30.92	.27	.12	14.93	32.93	.39	.29	.55	24.97	.65	7.75	.59	.14	.28	.40	22.85	.820	.14	4
3	.52	.77	.84	.11	13.86	28.06	.55	.71	.16	.02	.81	.85	.27	.18	.44	.85	.62	.38	.34	23.82	26.96	.19	.70	.715	.06	3
2	7.05	.68	.79	.07	.66	.17	.48	.54	.00	22.89	.65	.80	.22	.08	.37	.75	.54	.00	.06	.50	.65	.09	.56	.660	21.95	2
1	.27	.59	.74	.02	.46	.54	.37	.40	51.89	.73	.45	.71	.15	60.92	.30	.60	.47	6.64	10.85	.27	.31	29.97	.42	.555	.85	1
1710	.48	.50	.70	15.98	.25	.74	.25	.28	.77	.67	.29	.65	.05	.78	.25	.47	.38	.20	.64	22.96	25.90	.81	.26	.460	.75	1710
09	.67	.46	.64	.95	.09	.87	.19	.10	.68	.55	.14	.58	32.95	.66	.12	.36	.33	5.78	.28	.54	.50	.60	.13	.360	.66	09
8	.90	.40	.56	.92	12.95	29.13	.12	29.96	.58	.35	13.96	.53	.87	.59	.05	.27	.28	.43	.04	.30	.13	.45	21.95	.280	.60	8
7	8.15	.34	.48	.89	.70	.35	.05	.84	.40	.18	.80	.40	.78	.47	.00	.18	.20	.14	9.85	21.93	24.65	.37	.78	.190	.53	7
6	.40	.28	.42	.86	.44	.61	1.87	.64	.27	.05	.60	.30	.72	.32	88.91	.14	.13	4.75	.70	.64	.22	.24	.65	.120	.45	6
5	.66	.22	.36	.85	.26	.75	.76	.35	.16	21.91	.45	.22	.54	.22	.82	.07	.08	.36	.35	.36	23.86	.15	.45	.050	.35	5
4	.92	.14	.29	.84	.10	.90	.70	.16	.06	.79	.30	.17	.47	.09	.75	23.99	.00	3.95	.03	.04	.51	.04	.30	87.980	.23	4
3	9.14	.05	.21	.80	11.95	30.05	.60	.01	50.96	.65	.24	.11	.39	59.96	.67	.92	54.94	.63	8.79	20.74	.07	28.86	.16	.900	.11	3
2	.33	13.97	.14	.77	.81	.18	.40	28.79	.85	.50	.15	.03	.29	.83	.60	.82	.89	.32	.59	.39	22.70	.71	.10	.830	.00	2
1	.51	.86	.06	.74	.71	.27	......	.54	.75	.35	.05	31.92	.20	.70	.53	.75	.84	2.93	.26	.15	.33	.60	.02	.750	20.90	1
1700	.79	.77	2.99	.66	.60	.37	......	.35	.64	.18	12.88	.84	.11	.58	.45	.65	.76	.58	.00	19.91	21.75	.52	20.94	.660	.82	1700
1699	10.04	.68	.94	.56	.45	.42	......	.15	.57	.05	.73	.74	.01	39	.35	.56	.70	.18	7.70	.65	.26	.38	.85	.600	.72	1699
8	.31	.61	.86	.49	.27	.50	......	27.97	.47	20.90	.60	.66	31.90	.24	.27	.47	.65	1.90	.43	.44	20.92	.19	.75	.540	.62	8
7	.56	.56	.78	.42	.10	.53	......	.78	.41	.75	.40	.60	.80	.06	.19	.39	.60	.70	.13	.20	.51	.07	.62	.440	.53	7
6	.79	.49	.66	.34	10.88	.60	......	.65	.26	.56	.25	.52	.72	58.94	.06	.30	.55	.50	6.89	18.96	.15	27.90	.50	.350	.45	6
5	.96	.41	.49	.25	.70	.85	......	.47	.17	.44	.07	.44	.62	.81	87.94	.21	.50	.33	.70	.61	19.80	.73	.39	.260	.36	5
4	11.11	.33	.36	.19	.55	.97	......	.26	49.96	.30	11.95	.36	.50	.63	.81	.10	.41	.13	.45	.26	.55	.60	.29	.180	.29	4
3	.35	.20	.19	.11	.32	31.05	......	.08	.77	.16	.80	.31	.39	.49	.72	.00	.33	0.97	.07	17.90	.40	.38	.20	.070	.16	3
2	.56	.07	.06	.05	.13	.14	......	26.90	.65	.04	.68	.24	.30	.34	.62	22.93	.27	.66	5.83	.52	.34	.19	.10	86.950	.08	2
1	.88	12.98	1.90	14.98	9.96	.30	......	.73	.53	19.89	.49	.18	.19	.25	.49	.89	.23	......	.48	.17	.05	.05	.02	.850	19.92	1
1690	12.17	.88	.79	.94	.70	......	......	.57	.36	.74	.29	.11	.05	.14	.37	.85	.18	......	.15	16.80	18.60	26.90	19.89	.720	.79	1690
89	.48	.78	.62	.88	.45	......	......	.39	.25	.59	.08	.04	30.96	.06	.27	.82	.08	......	4.83	.51	.00	.76	.80	.550	.68	89
8	.83	.70	.47	.84	.20	......	......	.19	.06	.50	10.93	30.97	.85	.01	.10	.77	.04	......	.52	.18	17.60	.63	.70	.450	.55	8
7	13.08	.64	.39	.81	.06	......	......	25.96	48.86	.44	.85	.92	.75	57.90	86.90	.72	53.94	......	.26	15.85	.30	.43	.65	.340	.43	7
6	.24	.57	.30	.77	8.91	......	......	.85	.70	.34	.74	.87	.65	.75	.76	.66	.85	......	.03	.55	.00	.27	.60	.230	.35	6
5	.39	.50	.22	.75	.76	......	......	.73	.56	.22	.60	.82	.55	.57	.60	.60	.78	......	3.89	.25	16.66	.04	.52	.110	.24	5
4	.56	.38	.09	.67	.56	......	......	.57	.50	.13	.45	.75	.35	.37	.45	.55	.70	......	.73	14.86	.22	25.70	.45	85.980	.09	4
3	.70	.29	1.00	.60	.41	......	......	.39	.40	18.97	.30	.70	.20	.16	.34	.50	.65	......	.50	.51	15.90	.55	.40	.830	18.97	3
2	.83	.20	0.88	.56	.22	......	......	.17	.31	.77	.16	.62	.13	56.96	.18	.46	.58	......	.29	.22	.40	.35	.31	.715	.85	2
1	14.01	.09	.77	.47	.07	......	......	24.92	.25	.52	.00	.53	.05	.80	.00	.42	.51	......	.06	13.84	14.91	.18	.20	.640	.76	1
1680	.23	11.96	.66	.39	7.96	......	......	.65	.19	.47	9.82	.48	29.98	.65	85.88	.37	.43	......	2.77	.47	.40	.05	.03	.560	.64	1680
79	.53	.80	.52	.34	.77	......	......	.43	.07	.33	.62	.41	.92	.49	.80	.31	.36	......	.51	.09	13.86	24.85	18.90	.490	.55	79
8	.75	.69	.41	.27	.62	......	......	.16	47.98	.21	.46	.35	.84	.22	.74	.25	.31	......	.28	12.70	.40	.64	.79	.410	.44	8
7	.92	.59	.30	.21	.48	......	......	23.93	.87	.08	.29	.30	.74	.00	.66	.20	.28	......	.05	.36	12.89	.45	.66	.340	.33	7
6	15.05	.50	.19	.16	.27	......	......	.71	.77	17.86	.11	.21	.62	55.79	.58	.15	.22	......	1.84	.10	.39	.27	.54	.210	.20	6
5	.30	.39	0.03 27.27	.07	.05	......	......	.45	.65	.75	8.95	.13	.52	.64	.50	.08	.18	......	.66	11.84	11.89	.15	.43	.070	.06	5
4	.53	.32	.16	.02	6.90	......	......	.08	.55	.67	.85	.08	.42	.45	.43	.02	.12	......	.40	.44	.40	.02	.35	84.940	17.93	4
3	.78	.27	.07	13.98	.77	......	......	22.80	.43	.63	.73	.04	.25	.28	.30	21.95	.06	......	.16	.00	10.95	23.87	.25	.760	.80	3
2	16.04	.24	26.98	.95	.70	......	......	.59	.34	.59	.60	29.99	.14	.10	.19	.90	52.95	......	.08	10.60	.75	.70	.17	.600	.67	2
1	.19	.19	.95	.91	.60	......	......	.43	.20	.53	.53	.97	.05	54.91	.06	.80	.87	......	0.93?	.20	.58	.57	.14	.500	.55	1
1670	.39	.16	.87	.85	.40	......	......	.33	.10	.45	.35	.94	28.94	.68	84.92	.66	.76	......	.83?	9.70	.27	.40	.05	.350	.40	1670
69	.64	.09	.77	.80	.08	......	......	.17	.00	.32	.15	.91	.80	.44	.79	.54	.70	......	.70?	.25	.992	.25	17.96	.200	.28	69
8	.86	.00	.67	.75	5.78	......	......	.04	46.94	.19	7.98	.86	.73	.24	.65	.41	.59	......	.58?	8.87	.58	.05	.90	.090	.21	8
7	17.08	10.92	.58	.69	.42	......	......	21.86	.85	.06	.85	.81	.68	53.96	.55	.29	.51	......	.40?	.53	.18	22.82	.75	83.960	.10	7
6	.31	.81	.46	.57	.03	......	......	.67	.75	16.96	.75	.77	.60	.71	.44	.18	.45	......	.19?	.25	8.69	.66	.67	.880	16.99	6
5	.62	.70	.29	.46	4.64	......	......	.48	.62	.70	.63	.72	.50	.51	.34	.09	.36	......	......	.03	.30	.48	.62	.780	.89	5
4	.93	.56	.10	.36	.35	......	......	.25	.47	.55	.52	.66	.41	.30	.25	.00	.29	......	......	7.75	7.97	.34	.55	.650	.76	4
3	18.26	.39	25.94	.26	.03	......	......	.00	.39	.40	.45	.58	.34	.07	.15	20.93	.24	......	......	.44	.69	.16	.45	.560	.60	0
2	.63	.24	.75	.19	3.64	......	......	20.83	.28	.23	.35	.53	.23	52.89	.03	.84	.16	......	......	6.96	.49	.02	.39	.450	.45	2
1	.94	.16	.56	.14	.40	......	......	.61	.15	15.95	.19	.48	.14	.74	83.94	.74	.09	......	......	.78	.28	21.93	.30	.270	.28	1
1660	19.18	.12	.38	.04	.13	......	......	.41	.06	.80	.04	.44	.05	.58	.84	.58	51.98	......	......	.38	.02	.81	.20	.150	.17	1660
59	.36	.08	.21	12.96	2.81	......	......	.20	45.94	.65	6.86	.39	.00	.42	.68	.44	.86	......	......	.15	6.81	.70	.11	82.960	.06	59
8	.50	.06	.05	.92	.63	......	......	.05	.77	.31	.70	.36	27.95	.30	.55	.30	.75	......	......	5.85	.60	.58	.05	.840	15.93	8
7	.70	.02	24.85	.85	.45	......	......	19.83	.64	.20	.54	.33	.86	.17	.40	.15	.65	......	......	.60	.36	.44	16.95	.720	.77	7
6	19.92 20.17	9.96	.70	.79	.22	......	......	.65	.44	.05	.40	.29	.79	51.96	.28	.00	.58	......	......	.30	.10	.25	.90	.600	.66	6
5	40	.86	.54	.75	2.00	......	......	.47	.24	14.85	.30	.25	.69	.76	.20	19.93	.50	......	......	.01	5.85	.00	.84	.470	.55	5
4	.60	.80	.37	.72	1.77	......	......	.35	.00	.65	.25	.22	.60	.57	.09	.81	.45	......	......	4.70	.67	20.73	.80	.220	.42	4
3	.80	.74	.21	.64	.48	......	......	.15	44.80	.45	.23	.16	.52	.42	82.90	.68	.31	......	......	.36	.40	.53	.76	.060	.28	3
2	.91	.67	.09	.56	.25	......	......	18.86	.69	.26	.21	.12	.44	.33	.82	.52	.19	......	......	.15	.27	.36	.72	81.900	.10	2
1	21.09	.61	23.96	.50	.10	......	......	.55	.60	.09	.10	.10	.35	.20	.65	.38	.05	......	......	3.86	.12	.16	.66	.700	14.96	1
1650	.27	.36	.93	.44	0.87	......	......	.30	.42	13.95	.03	.07	.28	.08	.50	.25	50.93	......	......	.60	.05	.01	.60	.480	.85	1650
49	.36	.33	.77	.40	.66	......	......	.10	.25	.81	5.97	.03	.22	50.90	.31	.12	.84	......	......	.36	.00	19.75	.56	.250	.75	49
8	.52	.23	.61	.34	.32	......	......	17.92	.18	.66	.88	.01	.17	.67	.17	.01	.73	......	......	.15	4.85	.49	.50	.050	.64	8
7	.74	.10	.50	.36	0.05 16.05	......	......	.70	.06	.40	.77	28.96	.14	.40	81.96	18.88	.65	......	......	2.95	.68	.23	.45	80.890	.49	7
6	22.04	8.98	.31	.19	9.73	......	......	.56	43.92	.20	.68	91	.03	.14	.80	.79	.60	......	......	.83	.56	18.74	.40	.740	.35	6
5	.41	.87	.10	.10	.45	......	......	.20	.77	12.95	.55	.88	26.92	49.88	.70	.69	.53	......	......	.70	.43	.58	.35	.600	.14	5
4	.62	.75	22.86	.07	.25	......	......	16.86	.64	.76	.40	.84	.84	.60	.59	.59	.45	......	......	.60	.24	.23	.30	.440	.04	4
3	.88	.60	.60	.03	.00	......	......	.54	.54	.63	.30	.79	.79	.45	.44	.50	.35	......	......	.45	.00	17.97	.25	.280	13.90	3
2	23.20	.51	.41	11.96	8.86	......	......	.19	.40	.49	.17	.74	.70	.33	.30	.39	.25	......	......	.38	......	.79	.20	.100	.77	2
1	.63	.43	.18	.90	.60	......	......	15.81	.25	.20	.03	.68	.58	.23	.19	.30	.17	......	......	.25	......	.55	.14	79.920	.64	1

TABLE I.—*Original scale readings, in centimeters, of Douglass's measurements, etc.*—Continued.

Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	IXX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	Year.
1640	23.95	8.36	21.95	11.81	8.50			15.43	43.08	11.96	4.86	28.65	24.48	49.10	81.04	18.20	50.05			1.90		17.29	16.09	79.700	13.49	1640
39	24.31	.26	.78	.70	.20			.15	42.95	.80	.70	.62	.39	48.91	80.95	.11	49.96			.70		.05	.00	.480	.34	39
8	.70	.17	.64	.64	.00			14.88	.85	.59	.50	.53	.33	.73	.83	.02	.81					16.80	15.91	.200	.08	8
7	25.26	.12	.41	.60	7.82			.67	.67	.38	.30	.46	.18	.57	.70	17.92	.75					.53	.85	78.990	12.93	7
6	.78	.05	.20	.47	.70			.50	.40	.20	.14	.39	.10	.41	.55	.82	.63					.36	.72	.770	.80	6
5	26.52	7.95	.00	.37	.53			.27	.08	.04	3.92	.32	.04	.21	.41	.73	.49					.03	.62	.490	.56	5
4	.92	.80	20.80	.32	.30			.13	41.77	10.96	.80	.26	25.90	.00	.29	.65	.37					15.76	.52	.140	.35	4
3	27.36	.72	.60	.27	.15			13.89	.47	.72	.65	.23	.75	47.80	.15	.54	.23					.45	.42	77.800	11.95	3
2	.66	.65	.30	.22	7.00			.77	.20	.50	.50	.17	.60	.54	79.87	.44	.15					.09	.34	.570	.74	2
31	28.15	.59	.00	.16				.56	40.90	.31	.43	.07	.45	.36	.65	.35	.00					14.80	.30	.300	.43	31
1630	.69	.55	19.72	.09				.34	.73	.15	.35	27.98	.26	.12	.50	.25	48.80					.49	.21	76.900	.15	1630
29	29.10	.43	.46	.03				.04	.52	.05	.24	.89	.10	46.87	.28	.10	.55					.15	.14	.630	10.95	29
8	29.35	.29	.22	10.96				12.79	.40	9.89	.13	.84	.00	.64	78.95	16.94	.40					13.85	.06	.250	.73	8
7		.19	18.98	.90				.41	.19	.74	.02	.80	24.90	.42	.60	.85	.25					.60	14.97	75.850	.55	7
6		.07	.62	.86				.11	.00	.57	2.90	.70	.80	.09	.23	.70	.07					.34	.89	.500	.45	6
5		6.97	.30	.78				11.77	39.66	.64	.83	.58	.75	45.72	77.73	.54	47.91					12.90	.85	.250	.26	5
4		.80	.05	.73				.45	.39	.07	.70	.53	.67	.45	.49	.38	.83					.45	.80	.050	.10	4
3		.60	17.78	.65				.16	.25	8.75	.64	.44	.55	.08	.24	.25	.72					11.98	.70	74.850	9.87	3
2		.43	.43	.56				10.80	.06	.44	.53	.35	.39	44.74	.03	.11	.60					.50	.63	.700	.60	2
1		.26	.10	.47				.37	38.90	.00	.43	.27	.20	.44	76.76	.02	.50					.00	.53	.460	.36	1
1620		10	16.71	.40				9.94	.72	7.53	.34	.20	.06	.13	.57	15.95	.38					10.54	.48	.270	.21	1620
19		5.96	.37	.34				.51	.56	.23	.22	.11	23.95	43.85	.35	.69	.23					.16	.40	.040	.07	19
8		.79	15.97	.26				.04	.36	.05	.16	.01	.79	.53	.15	.45	.04					9.76	.28	73.850	8.91	8
7		.59	.57	.21				8.65	.22	6.72	.00	26.93	.67	.38	75.92	.23	46.90					.54	.14	.650	.85	7
6		.41	.20	.17				.25	.12	.32	1.87	.89	.55	.21	.75	.07	.75					.14	.00	.460	.63	6
5		.24	14.77	.12				7.93	37.85	.05	.80	.80	.40	.06	.56	14.90	.55					8.84	13.89	.250	.54	5
4		.06	.46	.06				.61	.69	5.80	.72	.74	.32	42.80	.36	.75	.43					.44	.72	.050	.47	4
3		4.87	.06	.00				.34	.50	.52	.65	.67	.25	.64	.12	.64	.27					.05	.60	72.850	.42	3
2		.70	13.69	9.94				.00	.37	.20	.60	.60	.12	.46	74.90	.52	.10					7.75	.47	.560	.24	2
1		.52	.10	.85				6.70	.05	4.95	.54	.50	.00	.26	.56	.38	.00					.51	.36	.380	.08	1
1610		.33	12.90	.73				.42	36.80	.80	.50	.38	22.90	.09	.30	.26	45.90					.21	.28	.160	7.91	1610
9		.13		.66				.15	.55	.62	.46	.28	.78	41.96	.03	.11	.83					6.95	.20	.060	.74	9
8		3.98		.59				5.91	.42	.43	.41	.20	.69	.80	73.82	.05	.63					.66	.02	71.730	.45	8
7		.77		.54				.70	.35	.23	.31	.08	.55	.56	.60	13.82	.48					.35	12.79	.440	.23	7
6		.57		.48				.50	.24	.13	.20	.00	.40	.45	.23	.60	.30					.13	.61	.200	6.99	6
5		.40		.42				.33	.00	3.90	.10	25.90	.29	.37	72.92	.45	.15					5.89	.50	.000	.79	5
4		.19		.36				.03	35.74	.70	.02	.80	.23	.34	.67	.25	.00					.73	.40	70.740	.57	4
3		2.96		.32				4.80	.55	.50	0.85	.69	.15	.08	.36	.10	44.82					.31	.20	.500	.35	3
2		.69		.29				.60	.44	.35	0.70	.60	.00	40.81	.13	12.95	.62					4.94	.07	.200	.10	2
1		.40		.27				.40	.34	.06		.44	21.88	.60	71.88	.75	.47					.64	.01	.070	5.90	1
1600		.10		.25				.27	.14	2.86		.34	.79	.43	.40	.60	.36					.37	11.89	69.900	.70	1600
1599		1.85		.14				3.91	34.96	.71		.23	.74	.39	.19	.50	.24					.11	.78	.770	.58	1599
8		.48		.07				.60	.80	.53		.10	.65	.10	.00	.40	.04					3.90	.59	.530	.40	8
7				.03				.36	.68	.46		.00	.60	39.82	70.72	.15	43.84					.65	.45	.300	.10	7
6				8.96				.13	.51	.20		24.86	.52	.65	.35	11.90	.70					.44	.32	.050	4.90	6
5				.88				2.90	.39	1.99		.75	.43	.54	.09	.74	.55					.26	.21	68.900	.73	5
4				.84				.75	.25	.85		.68	.36	.46	69.74	.60	.50					.06	.04	.800	.61	4
3				.79				.60	.15	.75		.65	.27	.36	.49	.55	.38					2.86	10.84	.700	.52	2
2				.75				.45	.05	.66		.58	.19	.22	.35	.50	.18					.62	.69	.450	.37	2
1				.73				.33	33.97	.55		.47	.10	.10	.13	.33	42.98					.40	.52	.250	.16	1
1590				.71				.22	.87	.37		.40	.00	.00	68.80	.18	.83					.28	.40	.050	.03	1590
89				.62				.00	.78	.20		.35	20.96	38.80	.54	10.90	.67					.23	.22	67.830	3.85	89
8				.56				1.84	.50	.05		.32	.87	.64	.29	.70	.54					.10	.12	.650	.68	8
7				.46				.68	.35	0.85		.27	.77	.40	.06	.54	.37					1.91	.09	.500	.48	7
6				.42				.45	.12	.75		.23	.70	.30	67.80	.35	.20					.78	.05	.290	.18	6
5				.41				.40	32.95	.60		.16	.52	.10	.60	.08	.07					.69	9.88	.100	2.99	5
4				.36				.30	.80	.40		.13	.33		.23	9.93	41.93					.62	.65	66.970	.82	4
3				.30				.19	.63			.08	.26		.04	.76	.73					.52	.35	.810	.58	3
2				.22				.06	.43			.03	.01		66.73	.60	.55					.34	.09	.650	.22	2
1				.14				1.00	.20			23.95	19.89		.36	.40	.30					.25	8.84	.430	.05	1
1580				.04				0.92	.04			.91	.80		.11	.18	.07					.14	.55	.150	1.90	1580
79				7.90				.86	31.87			.87	.73		65.80	8.90	40.90					.03	.30	.030	.62	79
8				.80				.77	.74			.82	.67		.45	.79	.64					0.94	.18	65.850	.49	8
7				.71				.40	.61			.80	.60		.11	.50	.32					.83	.09	.630	.33	7
6				.66					.50			.71	.55		64.83	.17	.14					.72	7.88	.470	.20	6
5				.59					.42			.63	.47		.50	7.91	39.90					.67	.63	.300	.05	5
4				.51					.26			.59	.37		.23	.70	.63					.57	.41	.190	0.73	4
3				.41					.08			.48	.30		63.92	.43	.44					.45	.21	.050		3
2				.31					30.91			.37	.18		.66	.20	.20					.20	.04			2
1				.23					.71			.32	.04		.30	6.93	38.96					.20	6.87			1
1570				.13					.55			.25	18.90		.00	.72	.81					.10	.69			1570
69				.01					.40			.15	.76		62.81	.53	.75						.51			69
8				6.95					.16			.05	.62		.65	.30	.50						.40			8
7				.86					.00			22.95	.46		.49	.05	.39						.21			7
6				.74					29.86			.85	.38		.25	5.85	.22						.05			6
5				.57					.75			.78	.30		.14	.51	.10						5.92			5
4				.46					.63			.68	.16		61.98	.25	37.90						.77			4
3				.36					.46			.59	.10		.91	.00	.74						.60			3
2				.28					.35			22.56	.00		.71	4.71	.43						.40			2
1				.16					.24			.47	17.93		.53	.45	.04						.20			1
1560				.05					.14			.42	.85		.40	.15	36.84						.05			1560
59				5.97					28.95			.33	.73		.25	3.92	.61						4.95			59
8				.83					.77			.23	.66		.11	.67	.31						.80			8
7				.68					.67			.20	.62		.00	.38	.15						.65			7
6				.45					.62			.14	.54		60.89	.15	35.95						.50			6
5				.20					.50			.07	.45		.80	2.98	.70						.37			5
4				.04					.40			21.98	.35		.50	.80	.55						.22			4
3				4.89					.37			.85	.30			.67	.33						.09			3
2				.75					.34			.73	.25			.55	.15						3.91			2
1				.54					.28			.65	.22			.40	34.90						.73			1
1550				.36					.20			.56	.16			.30	.70						.53			1550
49				.24					.13			.51	.06			.16	.43						.39			49
8				.11					.04			.42	.00			.02	.16						.21			8
7				3.90					.00			.37	16.94			1.90	33.95						.02			7
6				.83					27.90			.29	.87			.81	.75						2.88			6
5				.69					.76			.21	.77			.69	.40						.74			5
4				.54					.67			.15	.70			.94	.13						.64			4

TABLE I.—*Original scale readings, in centimeters, of Dauglass's measurements, etc.*—Continued.

Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	Year.
1543				3.43					27.63			21.05	16.65			1.45	32.90						2.60			1543
2				.24					.57			20.96	.60			.40	.70						.56			2
1				.13					.51			.93	.51			.34	.50						.46			1
1540				.00					.43			.88	.43			.10	.28						.34			1540
39				2.80					.34			.81	.35				.00						.22			39
8				.55					.22			.76	.27				31.66						.15			8
7				.35					.08			.73	.23				.45						.05			7
6				.20					.00			.67	.16				.23						1.92			6
5				.01					26.93			.63	.06				30.97						.80			0
4				1.86					.87			.57	15.96				.65						.68			4
3				.60					.82			.51	.85				.44						.53			3
2				.34					.76			.45	.79				.20						.39			2
1				.14					.69			.41	.67				.00						.30			1
1530				0.95					.63			.32	.60				29.75						.17			1530
29				.50					.57			.26	.48				.55						1.03			29
8				.38					.50			.21	.34				.30						0.85			8
7									.46			.18	.19				.08						.68			7
6									.40			.15	.13				28.94						.57			6
5									.33			.10	.03				.75						.47			5
4									.26			.04	14.89				.55						.38			4
3									.20			19.95	.80				.38						.25			3
2									.10			.88	.69				.16						.12			2
1									25.97			.83	.50				27.94						.05			1
1520									.95			.77	.45				.73									1520
19												.67	.38				.50									19
8												.61	.20				.40									8
7												.54	.05				.27									7
6												.47	13.92				.10									6
5												.39	.85				.00									5
4												.32	.70				26.90									4
3												.23	.60				.80									3
2												.15	.46				.70									2
1												.05	.21				.63									1
1510												.01	.05				.50									1510
09												18.95	12.92				.40									09
8												.82	.85				.30									8
7												.77	.80				.20									7
6												.65	.66				.10									6
5												.53	.60													5
4												.45	.48													4
3												.30	.39													3
2												.18	.05													2
1												.09	11.90													1
1500												.02	.72													1500
1499												17.89	.54													1499
8												.82	.37													8
7												.74	.22													7
6												.63	.10													6
5												.53	.00													5
4												.45	10.82													4
3												.40	.69													3
2												.37	.54													2
1												.30	.45													1
1490												.24	.24													1490
89												.15	.13													89
8												.09	.00													8
7												16.98	9.85													7
6												.89	.77													6
5												.80	.73													5
4												.69	.55													4
3												.59	.35													3
2												.48	.27													2
1												.38	.13													1
1480												.30	.04													1480
79												.20	8.90													79
8												.05	.70													8
7												15.96	.54													7
6												.90	.44													6
5												.74	.32													5
4												.63	.14													4
3												.52	7.90													3
2												.36	.75													2
1												.23	.60													1
1470												.12	.50													1470
69												14.95	.36													69
8												.80	.25													8
7												.70	.15													7
6												.61	.05													6
5												.54	6.95													5
4												.44	.87													4
3												.31	.80													3
2												.20	.70													2
1												.13	.60													1
1460												.02	.57													1460
59												13.88	.50													59
8												.75	.39													8
7												.62	.30													7
6												.52	.23													6
5												.30	.09													5
4												.25	5.95													4
3												.15	.87													3
2												.05	.74													2
1												12.93	.64													1
1450												.80	.52													1450
49												.75	.41													49
8												.70	.34													8

TABLE I.—*Original scale, in centimeters, of Douglass's measurements, etc.*—Continued.

Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	Year.
1447												12.55	5.25													1447
6												.38	.18													6
5												.23	.09													5
4												.14	4.90													4
3												11.98	.78													3
2												.83	.74													2
1												.50	.65													1
1440												.35	.56													1440
39												.20	.35													39
8												.00	.24													8
7												10.85	.14													7
6												.61	.04													6
5												.41	3.90													5
4												.21	.75													4
3												.06	.66													3
2												9.85	.56													2
1												.65	.50													1
1430												.46	.39													1430
29												.30	.12													29
8												.10	.00													8
7												8.93	2.86													7
6												.78	.73													6
5												.43	.59													5
4												.04	.42													4
3												7.83	.27													3
2												.54	.05													2
1												.19	1.80													1
1420												6.92	.59													1420
19												.70	.40													19
8												.50	.20													8
7												.32	1.00													7
6												.00	0.80													6
5												5.75	.65													5
4												.50	.25													4
3												.25	.13													3
2												.00	0.00													2
1												4.67														1
1410												.41														1410
09												.20														09
8												3.95														8
7												.69														7
6												.45														6
5												.30														5
4												2.95														4
3												.65														3
2												.42														2
1												.13														1
1400												.09														1400
1399												1.70														1399
8												.55														8
7												.50														7
6												.45														6
5												.30														5
4												1.00														4
3												0.70														3
1392												0.10														1392

Table 2 gives the averages of the yearly growths for three groups of trees, X, Y, Z. The measurements are all expressed in millimeters. The second and third groups, Y and Z, represent trees selected for their great age from the 25 of the first group X.

TABLE 2.—*Averages of the yearly growth for the three age-groups of trees.*

Year.	Average growth.			Year.	Average growth.		
	X Group of 25.	Y Group of 7.	Z Group of 2.		X Group of 25.	Y Group of 7.	Z Group of 2.
	Mm.	*Mm.*	*Mm.*		*Mm.*	*Mm.*	*Mm.*
1906	(0.768)	(0.63)	0.45	1887	0.588	0.49	0.45
1905	(0.572)	(0.37)	0.40	1886	0.556	0.47	0.40
1904	(0.520)	(0.53)	0.50	1885	0.608	.049	0.50
1903	(0.740)	0.56	0.50	1884	0.532	0.43	0.45
1902	0.492	0.41	0.45	1883	0.516	0.43	0.45
1901	0.648	0.44	0.45	1882	0.492	0.49	0.45
1900	0.564	0.33	0.30	1881	0.524	0.46	0.45
1899	0.632	0.50	0.50	1880	0.500	0.54	0.45
1898	0.788	0.44	0.60	1879	0.504	0.53	0.45
1897	0.708	0.40	0.40	1878	0.648	0.56	0.55
1896	0.712	0.47	0.55	1877	0.592	0.53	0.35
1895	0.652	0.40	0.35	1876	0.592	0.54	0.55
1894	0.708	0.47	0.55	1875	0.724	0.67	0.45
1893	0.684	0.46	0.35	1874	0.788	0.60	0.75
1892	0.656	0.51	0.50	1873	0.620	0.49	0.55
1891	0.656	0.49	0.45	1872	0.732	0.61	0.65
1890	0.732	0.47	0.55	1871	0.772	0.54	0.80
1889	0.644	0.51	0.45	1870	0.860	0.60	0.60
1888	0.620	0.43	0.45	1869	0.768	0.57	0.75

TABLE 2.—*Averages of the yearly growth, etc.*—Continued.

Year.	Average growth.			Year.	Average growth.		
	X Group of 25.	Y Group of 7.	Z Group of 2.		X Group of 25.	Y Group of 7.	Z Group of 2.
	Mm.	*Mm.*	*Mm.*		*Mm.*	*Mm.*	*Mm.*
1868	0.916	0.59	0.60	1840	0.772	0.59	0.45
1867	0.776	0.64	0.85	1839	0.848	0.77	0.55
1866	0.808	0.67	0.65	1838	0.788	0.76	0.45
1865	0.660	0.63	0.65	1837	0.844	0.71	0.45
1864	0.696	0.63	0.50	1836	0.868	0.63	0.55
1863	0.712	0.59	0.60	1835	0.880	0.61	0.45
1862	0.768	0.70	0.55	1834	0.888	0.67	0.60
1861	0.748	0.64	0.60	1833	0.920	0.63	0.55
1860	0.868	0.66	0.65	1832	0.908	0.59	0.50
1859	0.736	0.51	0.65	1831	0.804	0.56	0.40
1858	0.844	0.59	0.60	1830	0.864	0.44	0.40
1857	0.796	0.54	0.60	1829	0.664	0.56	0.25
1856	0.884	0.59	0.65	1828	0.824	0.53	0.45
1855	0.892	0.61	0.65	1827	0.724	0.47	0.35
1854	0.972	0.56	0.75	1826	0.760	0.46	0.55
1853	0.864	0.47	0.65	1825	0.684	0.67	0.55
1852	0.852	0.60	0.45	1824	0.680	0.61	0.45
1851	0.688	0.59	0.50	1823	0.672	0.61	0.40
1850	0.728	0.56	0.40	1822	0.632	0.63	0.45
1849	0.760	0.54	0.55	1821	0.608	0.53	0.50
1848	0.728	0.51	0.55	1820	0.600	0.51	0.50
1847	0.600	0.63	0.60	1819	0.716	0.77	0.40
1846	0.624	0.49	0.45	1818	0.772	0.69	0.55
1845	0.720	0.57	0.35	1817	0.640	0.54	0.40
1844	0.724	0.67	0.55	1816	0.872	0.73	0.45
1843	0.728	0.66	0.55	1815	0.940	0.79	0.45
1842	0.692	0.71	0.40	1814	0.872	0.70	0.45
1841	0.612	0.49	0.35	1813	0.824	0.64	0.25

Table 2.—*Averages of the yearly growth, etc.*—Continued.

Year.	Average growth. X Group of 25.	Y Group of 7.	Z Group of 2.
	Mm.	*Mm.*	*Mm.*
1812	0.968	0.61	0.50
1811	0.932	0.66	0.50
1810	0.928	0.64	0.50
1809	0.892	0.70	0.55
1808	0.962	0.77	0.50
1807	0.748	0.56	0.50
1806	0.988	0.74	0.50
1805	0.920	0.79	0.55
1804	0.832	0.66	0.40
1803	0.884	0.70	0.70
1802	0.904	0.77	0.65
1801	0.828	0.66	0.70
1800	0.972	0.73	0.55
1799	1.044	0.64	0.55
1798	1.000	0.69	0.45
1797	0.984	0.80	0.40
1796	0.984	0.91	0.55
1795	1.028	0.74	0.65
1794	1.004	0.64	0.70
1793	0.924	0.77	0.45
1792	0.808	0.73	0.60
1791	0.844	0.77	0.45
1790	0.920	0.61	0.45
1789	0.792	0.70	0.45
1788	1.016	0.66	0.50
1787	0.932	0.74	0.45
1786	0.872	0.76	0.40
1785	0.940	0.60	0.55
1784	0.904	0.69	0.70
1783	0.796	0.67	0.70
1782	0.760	0.61	0.50
1781	0.772	0.59	0.40
1780	0.840	0.76	0.60
1779	0.860	0.71	0.55
1778	0.944	0.84	0.70
1777	0.992	0.84	0.70
1776	1.000	0.81	0.65
1775	1.084	0.97	0.70
1774	1.028	0.86	0.80
1773	1.056	0.91	0.80
1772	1.208	1.00	0.90
1771	1.080	0.76	0.80
1770	1.060	0.83	0.75
1769	1.132	0.90	0.85
1768	1.136	0.87	0.80
1767	1.264	0.91	0.75
1766	1.164	0.90	0.90
1765	1.368	0.87	0.95
1764	1.328	0.74	0.60
1763	1.300	0.91	0.70
1762	1.252	0.83	0.75
1761	1.280	0.84	0.70
1760	1.212	0.90	0.60
1759	1.196	0.83	0.65
1758	1.136	0.81	0.70
1757	1.100	0.76	0.45
1756	0.992	0.80	0.65
1755	1.008	0.73	0.75
1754	0.952	0.64	0.50
1753	1.108	0.73	0.55
1752	1.060	0.81	0.65
1751	1.304	0.70	0.45
1750	1.020	0.73	0.70
1749	1.248	0.97	0.75
1748	1.356	0.86	0.60
1747	1.372	0.86	0.85
1746	1.384	0.80	0.75
1745	1.360	0.70	0.80
1744	1.268	0.74	0.75
1743	1.436	0.96	0.85
1742	1.324	0.87	0.75
1741	1.312	0.99	0.75
1740	1.328	1.03	0.95
1739	1.348	0.99	0.75
1738	1.416	0.76	0.65
1737	1.236	0.93	0.55
1736	1.492	0.81	0.60
1735	1.424	1.09	1.35
1734	1.332	1.04	1.30
1733	1.312	0.91	0.85
1732	1.488	1.00	0.90
1731	1.308	0.84	0.75
1730	1.424	0.93	0.80
1729	1.336	1.00	0.75
1728	1.512	1.00	1.05
1727	1.456	1.19	1.25
1726	1.548	0.89	0.80
1725	1.760	1.03	1.10
1724	1.464	0.99	1.00
1723	1.660	1.06	0.85
1722	1.516	1.03	0.95
1721	1.432	0.96	0.80

Year.	Average growth. X Group of 25.	Y Group of 7.	Z Group of 2.
	Mm.	*Mm.*	*Mm.*
1720	1.604	1.09	0.80
1719	1.456	1.13	1.00
1718	1.492	1.09	0.90
1717	1.348	0.96	0.75
1716	1.416	1.00	0.70
1715	1.612	1.04	1.15
1714	1.456	0.90	0.90
1713	1.444	0.97	0.85
1712	1.556	0.93	0.70
1711	1.520	0.94	0.65
1710	1.568	0.83	0.85
1709	1.436	0.86	0.75
1708	1.512	0.94	0.55
1707	1.588	0.81	0.95
1706	1.520	0.83	0.70
1705	1.516	0.97	1.15
1704	1.428	0.76	0.65
1703	1.416	0.73	0.80
1702	1.368	0.84	1.05
1701	1.472	0.91	0.85
1700		0.81	0.95
1699		0.84	0.90
1698		0.81	0.85
1697		0.97	0.90
1696		0.80	0.80
1695		1.10	0.90
1694		0.99	0.85
1693		0.84	0.90
1692		0.67	0.75
1691		0.90	0.90
1690		0.83	1.05
1689		0.81	0.80
1688		0.86	0.80
1687		0.76	0.75
1686		0.83	0.75
1685		0.70	0.85
1684		0.77	1.25
1683		0.87	1.15
1682		0.71	0.80
1681		0.77	0.65
1680		0.84	0.70
1679		0.70	0.60
1678		0.71	0.65
1677		0.87	0.95
1676		0.84	1.00
1675		0.77	0.75
1674		0.83	0.70
1673		0.83	1.10
1672		0.80	0.65
1671		0.94	0.60
1670		0.80	0.70
1669		0.87	0.95
1668		0.97	0.60
1667		0.79	0.45
1666		0.84	0.65
1665		0.91	0.80
1664		0.77	0.85
1663		0.74	0.60
1662		0.91	0.80
1661		0.96	0.65
1660		0.93	0.70
1659		0.90	0.40
1658		0.89	0.40
1657		0.91	0.65
1656		0.79	0.55
1655		0.94	0.65
1654		1.06	0.75
1653		0.87	0.60
1652		0.84	0.50
1651		0.93	0.60
1650		0.86	0.55
1649		0.67	0.40
1648		0.84	0.50
1647		0.71	0.40
1646		0.77	0.70
1645		0.79	0.75
1644		0.77	0.65
1643		0.80	0.50
1642		0.89	0.75
1641		0.91	0.75
1640		0.84	0.65
1639		0.79	0.90
1638		0.94	0.65
1637		1.34	1.10
1636		1.21	0.75
1635		1.11	0.60
1634		1.24	0.85
1633		1.14	1.05
1632		1.29	1.25
1631		1.23	1.20
1630		1.47	1.40

Table 2.—*Averages of the yearly growth, etc.*—Continued.

Year.	Average growth. X Group of 25.	Y Group of 7.	Z Group of 2.
	Mm.	*Mm.*	*Mm.*
1629		1.11	1.05
1628		1.03	0.70
1627		1.26	1.00
1626		1.24	1.10
1625		1.06	0.50
1624		1.03	0.85
1623		1.17	1.05
1622		1.07	1.15
1621		1.03	1.30
1620		1.37	1.15
1619		1.30	1.05
1618		1.31	1.20
1617		1.09	0.80
1616		1.46	1.05
1615		1.24	1.05
1614		1.13	0.75
1613		1.11	0.70
1612		1.43	1.15
1611		1.23	1.20
1610		1.17	1.00
1609		1.17	1.00
1608		1.36	1.05
1607		1.39	1.10
1606		1.37	1.25
1605		1.37	1.05
1604		1.31	0.85
1603		1.11	0.85
1602		1.20	1.55
1601		1.30	1.10
1600		1.14	1.10
1599		1.24	0.90
1598		1.43	1.10
1597		1.37	0.95
1596		1.10	0.95
1595		1.01	0.80
1594		0.87	0.50
1593		0.97	0.80
1592		1.19	0.95
1591		1.10	0.80
1590		1.31	0.75
1589		1.26	0.35
1588		0.99	0.70
1587		1.11	0.70
1586		1.33	0.70
1585		1.34	1.05
1584		1.66	1.20
1583		1.43	0.60
1582		1.94	1.65
1581		1.49	0.80
1580		1.57	0.65
1579		1.19	0.60
1578		1.37	0.40
1577		1.66	0.80
1576		1.49	0.65
1575		1.54	0.60
1574		1.64	1.05
1573		1.53	0.90
1572		1.64	0.85
1571		1.47	1.05
1570		1.26	1.20
1569		1.66	1.20
1568		1.53	1.20
1657		1.57	1.30
1566		1.37	0.75
1565		1.44	0.90
1564		1.51	1.15
1563		1.60	0.45
1562		1.80	0.95
1561		1.36	0.60
1560		1.51	0.85
1559		1.79	1.10
1558		1.47	0.50
1557		1.40	0.50
1556		1.40	0.75
1555		1.30	0.90
1554		1.26	1.15
1553		1.27	0.85
1552		1.36	0.65
1551		1.17	0.60
1550			0.55
1549			0.95
1548			0.55
1547			0.70
1546			0.75
1545			0.80
1544			0.85
1543			0.70
1542			0.40
1541			0.70
1540			0.75
1539			0.65
1538			0.55

Year.	Average growth. X Group of 25.	Y Group of 7.	Z Group of 2.
	Mm.	*Mm.*	*Mm.*
1537			0.50
1536			0.55
1535			0.80
1534			0.80
1533			0.85
1532			0.50
1531			1.05
1530			0.65
1529			0.85
1528			0.85
1527			0.90
1526			0.55
1525			0.80
1524			1.15
1523			0.80
1522			0.80
1521			1.25
1520			0.75
1519			0.65
1518			1.25
1517			1.10
1516			1.05
1515			0.70
1514			1.20
1513			0.90
1512			1.20
1511			1.45
1510			1.10
1509			1.30
1508			0.60
1507			0.85
1506			1.30
1505			0.70
1504			1.35
1503			1.30
1502			1.90
1501			1.10
1500			1.55
1499			1.25
1498			1.25
1497			1.30
1496			1.10
1495			0.90
1494			1.15
1493			0.80
1492			1.10
1491			0.75
1490			1.50
1489			0.85
1488			1.20
1487			1.20
1486			0.85
1485			0.75
1484			1.40
1483			1.55
1482			1.25
1481			0.75
1480			0.95
1479			1.45
1478			1.25
1477			0.80
1476			1.40
1475			1.45
1474			1.75
1473			1.55
1472			1.40
1471			1.05
1470			1.55
1469			1.30
1468			1.00
1467			0.95
1466			1.10
1465			0.90
1464			1.20
1463			1.05
1462			0.85
1461			1.20
1460			0.80
1459			1.20
1458			1.10
1457			0.85
1456			1.80
1455			0.95
1454			0.90
1453			1.15
1452			1.10
1451			1.25
1450			0.80
1449			0.60
1448			1.20
1447			1.20
1446			1.20

TABLE 2.—*Average of the yearly growth, etc.*—Continued.

Year.	Average growth.			Year.	Average growth.		
	X Group of 25.	Y Group of 7.	Z Group of 2.		X Group of 25.	Y Group of 7.	Z Group of 2.
	Mm.	*Mm.*	*Mm.*		*Mm.*	*Mm.*	*Mm.*
1445			1.40	1429			1.60
1444			1.40	1428			1.55
1443			0.95	1427			1.40
1442			2.10	1426			2.45
1441			1.20	1425			2.80
				1424			1.80
1440			1.80	1423			2.55
1439			1.55	1422			3.00
1438			1.25	1421			2.40
1437			1.70				
1436			1.70	1420			2.05
1435			1.75	1419			2.00
1434			1.20	1418			1.90
1433			1.55	1417			2.60
1432			1.30	1416			2.00
1431			1.50	1415			3.25
				1414			1.85
1430			2.15	1413			1.90

SQUALLS AND THUNDERSTORMS.

By J. LOISEL, D. ès S. Dated, Observatory of Juvisy.

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Half a century ago thunderstorms were believed to be essentially local phenomena not subject to any [general] law. It was not until it had been shown that the majority of these storms travelled in a definite direction that a distinction was made between thunderstorms accompanying barometric lows and local or heat thunderstorms. I shall here confine myself to the consideration of the former class only. This class has been the object of researches by a large number of meteorologists: Marié-Davy, Mohn and Hildebrandsson, Abercromby, Ley, Köppen, Ferrari, von Bezold, Prohaska, and others. Each has untangled a portion of the truth, but to the French meteorologist, E. Durand-Gréville,[1] belongs unquestionably the credit for having sharpened the previously somewhat vague and indistinctly connected ideas, and for having adequately correlated the authentically verified facts bearing on this subject. He showed that the "cyclonic" thunderstorms are but an accessory result of a body of extremely complex phenomena—an organism one may call it—*the squall* (*le grain*), which is subject to fixed laws and forms an integral part of certain lows. He further showed that these constitute a regular incident, subject to definite laws, in the general circulation of the atmosphere.

The thunderstorm is a *thundersquall* (*un grain orageux*).

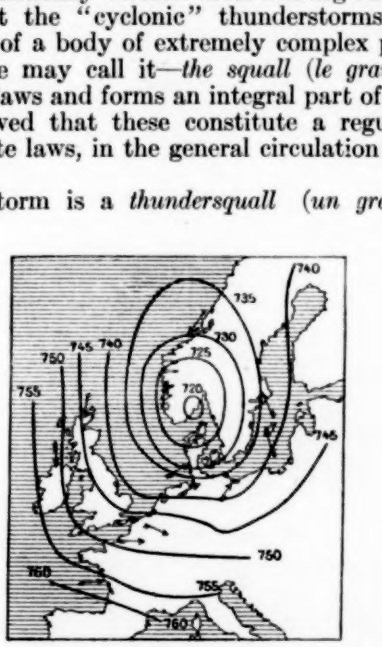

FIG. 1.—Pressure chart of western Europe, morning of March 12, 1906.

[1] E. Durand-Gréville: Les grains et les orages. Bur. cent. mét. de France, 1892; and Comptes rendus, 9 avril, 1894.

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Fig. 1 exhibits the barometric conditions prevailing over western Europe on the morning of March 12, 1906, with a barometric depression or low of regular outline central just south of Christiania. In certain lows, however, the isobars instead of curving so regularly present a zigzag at one or more points and Durand-Gréville has called this the "squall zigzag" (*zigzag de grain*). Figure 3 shows in a diagrammatic but accurate manner the details of this distortion of the isobars. The narrow band included between the dotted lines constitutes the "squall zone" (*le ruban de grain*). It starts in the vicinity of the center of the barometric depression or low and usually extends out to its boundary, thus having a length of 2,000 kilometers (1,243 miles), or even more at times, while its width varies from 10 to 80 or 100 kilometers (6 to 62 miles). The "squall zone," while remaining parallel to itself, moves across the country with its "low." If the depression moves eastward the "zone" follows it, perhaps gradually accentuating its convexity eastward as shown in the two maps of fig. 2. If the low retreats westward the zone retrogrades with it, as shown in fig. 4. If the low remains stationary, however, the "squall zone" does not necessarily follow suit; in the majority of cases it swings around the center of the depression.

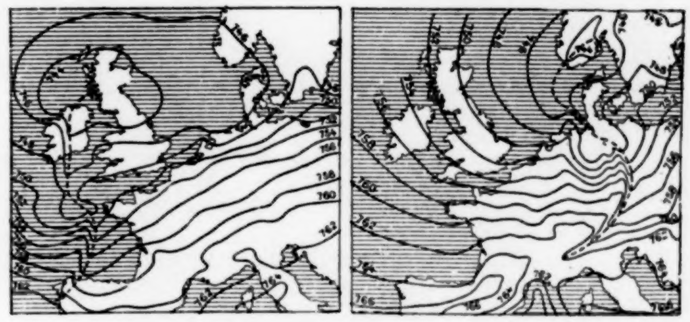

FIG. 2.—The eastward displacement of a "squall zone" (*le ruban de grain*).

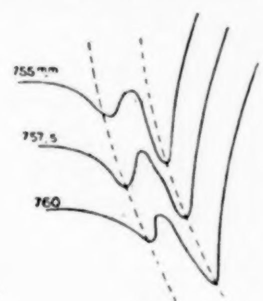

FIG. 3.—Course of the isobars within the "squall zone."

A general review of all the observed facts shows that the passage of a "squall zone" past each place is accompanied by the concomitant production of a certain number of phenomena which occur only within the limits of the zone. They begin at the moment when the "squall front" (*ligne de grain*) of the "squall zone" reaches the place of observation, they rapidly attain their maximum intensity, and then gradually weaken and die out as the rear of the zone passes and normal conditions become reestablished. But these accompanying phenomena may be more or less numerous, whence result many varieties of "squalls," each characterized by its appropriate phenomena.

We shall see that the phenomena observed during the passage of a squall are actually the results of two causes, one of these, the squall wind, is purely *dynamic*, pre-existant, and may be of distant origin, the other is the local condition of the atmosphere and is *static*.

The following synoptic table by Durand-Gréville summarizes the principal varieties of "squalls."

Durand-Gréville's classification of squalls.

1. Sudden increase in wind velocity..........				
2. Sudden change in wind direction.........	White squall.			
3. Sudden rise in pressure...............				
4. Sudden fall in pressure.......................		Wind squall.		
5. Sudden rise in relative humidity...............				
6. Rapid increase in cloudiness.....................			Rain, hail, or snow squall.	
7. Downpours of rain .... hail........ snow........				Thunder squall.
8. Lightning and thunder........................				

In the above table squalls are classified in the order of increasing complexity. On the other hand, their geographic distribution would give a quite different arrangement.

FIG. 4.—Westward displacement of a "squall zone."

Figure 7 shows graphically the changes in four of the meteorological elements observed during a squall on July 28, 1908, at the observatory of Juvisy, and brings out very clearly the general characteristic changes in each, so that further description is not necessary.

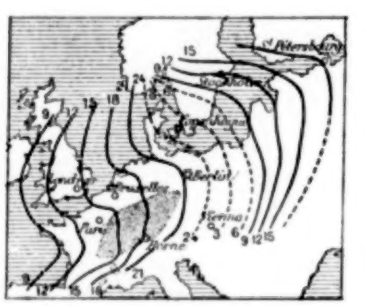

FIG. 5.—Successive positions of the "squall front" (*la ligne de grain*) of August 27-28, 1908, and the districts visited by the thunderstorm.

A glance at the wind curve in fig. 7 shows that the "squall zone" is the seat of a strong, sometimes even violent, wind generally from points between north and west, while in front and behind this zone the wind is much weaker and blows from points between south and west. In front and behind the "squall zone" the wind direction makes a slight angle with the isobars by reason of the deflective force of the earth's rotation. At the moment of the squall the wind direction is almost at right angles to the isobars, since the influence of the deflecting force is less marked on a brisk stroke of wind blowing along a narrow path only. It is evident that this violent "squall wind" is not fed by the much weaker wind blowing behind it. In all probability, and some observations unfortunately all too few apparently confirm the hypothesis, it can be "nourished" only by a sheet of rapidly *descending* air which comes from the higher regions (see *A*, fig. 6), and after brushing the ground over the more or less extensive space *RR'* as the "squall wind" (*le vent de grain*), must then necessarily ascend toward *A'*, leaving the "squall front" (*ligne de grain*), since it cannot escape along the surface in advance of the "squall zone" where, as we shall see later, the wind is weak or even opposite in direction as though drawn in by the "squall front."

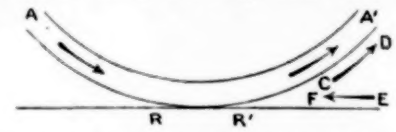

FIG. 6.—The arrangement of the winds in a squall (vertical section).

From what altitude does this sheet of air descend? To what height does it remount? We have no positive knowledge on this matter at present. All that one may assert is that certain squalls cross lofty mountain ranges without apparent disarrangement, while other squalls seem to produce much weaker atmospheric changes at the altitude of the Eiffel Tower than on the ground at the Bureau Central Météorologique. It is a complicated problem. Some meteorologists believe that we have in the squall a kind of atmospheric wave or breaker or vortex rotating about a horizontal axis. The writer believes that there is much of the hypothetical in this conception. Only the attentive observation of the upper clouds in those squalls which have *very little* accompanying cloudiness will enable us to decide as to the actual existence of an upper portion closing this circuit. One thing is very certain, a squall is in no way to be likened to a vortex having a vertical axis, i. e., to a minute barometric depression, as was long believed to be the case. As a matter of fact the "squall wind" does not blow spirally like a whirlwind, but on the contrary it blows always in the same direction, almost at right angles to the "squall front," and there is nowhere such a central calm as there is in a vertical or whirlwind movement.

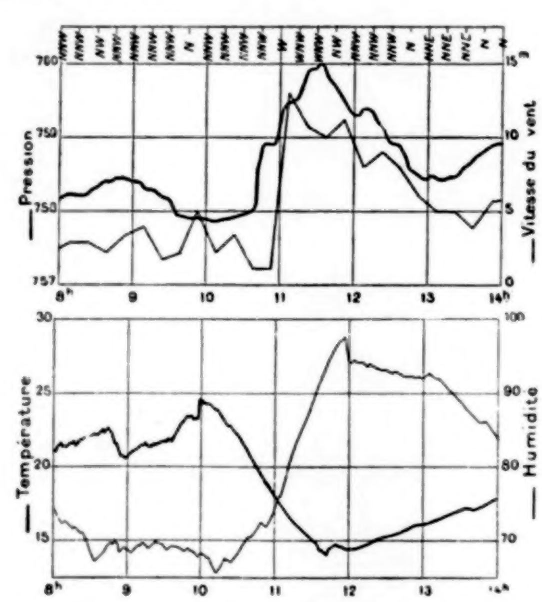

FIG. 7.—Changes in the meteorological elements at any locality, caused by the passage of a squall.

It is easy to deduce the consequences of such a state of affairs. The ascensional movement of the sheet of air *A A'*, fig. 6, sets up a kind of draft, *C D*, on the contiguous air layers, and this simultaneously produces in front of the squall the following phenomena:

1. A decrease in the velocity of the wind which may, as observations show, die out completely or be replaced by a weak contrary wind blowing in the direction *EF* toward the "squall zone" at right angles to its front.
   The whirls of wind and dust which sometimes immediately precede thunderstorms are probably provoked by the meeting of these two opposing currents, *EF* and *CD*.
2. A fall in pressure all along the front of the squall throughout a more or less narrow region which Durand-Gréville calls the "squall trough" (*le couloir de grain*), and which is revealed in the local barograms by the minimum preceding the sudden rise in the curve (see fig. 7, pressure curve at 10^h.).

As for the rapid rise in pressure which is particularly marked a short distance within the front boundary of the "squall zone," its primary cause is evidently the vertical component of the descending wind probably aided by various secondary processes such as the partial local evaporation of rain,[2] or still more the mechanical transportation of air by the rain drops.[3] This characteristic irregularity or "hook" (*crochet*) in the barograph curve was first noticed in the case of thunderstorms, whence it received the name "thunderstorm hook" (*crochet d'orage*) [or "thunderstorm nose" (*Gewitternase*)]. As a matter of fact it always occurs upon the passage of a squall, even when there is no thunderstorm. The above names are therefore incorrect, they should be changed to "squall hook" (*crochet de grain*) [or "squall nose"].

The low temperature within a squall can scarcely be explained in any other way than by supposing that the original temperature of the masses of descending air was lower than that appropriate to their altitude, wherefor they show less heating in the course of their descent.

Similarly the cause of the rise in the relative humidity is very probably to be sought in the action of the descending cold air upon layers of air near the earth's surface which are always more or less heavily charged with moisture.

LOCAL PHENOMENA.

All the phenomena so far considered exist throughout the extent of the "squall zone"; they are not special or localized at the point of observation. We have now to consider, on the other hand, local phenomena distributed chiefly close to and a little behind the "squall front" and which may develop simultaneously at various points in the "squall zone," leaving great gaps between. These are called forth by the passage of the cold descending[4] air of the squall through an atmosphere properly prepared, which thus becomes the occasional cause of local phenomena.

It is indeed easy to understand that collections of clouds of all sizes will form wherever the cold descending "squall wind" meets the warm, moist lower air; that sudden downpours of rain, snow, or hail, will be produced in those less numerous regions already enclosing large completely formed cumulo-nimbus[5] clouds; and that the thunderstorm will burst particularly at the hottest time of the day in yet more circumscribed regions of great heat and high humidity and filled with lofty cumulo-nimbus surmounted by "mushroom" or other forms of false cirrus. For example, the regions visited by the thunderstorm of August 27-28, 1890, are shown by the stippled areas of fig. 5. They were three in number, the first in the south of France, the second in the district about Berlin, the third and much the largest area embraced central and eastern France, the grand duchy of Baden, Würtemberg, and the major portions of Switzerland and Bavaria. The "squall front" traversed these thunderstorm regions on August 27 between 13^h and 22^h local time.

Upon examining the successive positions of the "squall front" as shown in fig. 8, we see that during an interval of several hours, the isochrones of the passage of the squall did not notably change their shapes, and that the speed of translation of the "squall front" was almost constant. It is evident that it would be extremely easy, as was originally suggested by Durand-Gréville, to report to a central station the passage of a "squall zone" by means of one or several lines of signals or stations located in the west of Europe. One could thus determine the position of the "zone," its speed of translation; in a word watch it, follow it step by step and consequently, several hours in advance, warn regions lying in its path of the probability of the occurrence of a squall at about a given hour. One could then notice at each point whether the passage of the squall would call forth from the local atmospheric conditions, a simple shower, a gust of hail, or even a thunderstorm at those localities where in popular parlance it was "thunderstorm weather."

From this standpoint it seems to me that the use of some one of the electric-wave-detectors [the coherer of wireless telegraphy] recommended by A. Turpain[6] is the proper method to adopt for the local prediction of thunderstorms. The method of general prediction based on the observation (and charting) of the "squall zone" might thus be very happily supplemented in particular cases.

For the sake of completeness I would add that one and the same barometric low may be accompanied by several "squall zones" disposed radially about it and succeeding each other at intervals of some hours. Further there are complex "squall zones" or zones made up of several parallel neighboring "bands," each "band" (*bande*) when considered alone possessing the characters of a simple "zone."

Theoretically, there is nothing simpler than to predict the arrival of a "squall zone." But it is a long step from theory to practise. One has but to recall how much energy, perseverance, and even obstinacy, Le Verrier needed through long years in order to overcome the material difficulties and the individual antagonisms or collective oppositions "*which are in the nature of things.*"

EXHIBIT OF METEOROLOGICAL DATA.

By D. T. MARING, Instrument Division. Dated August 14, 1909.

A subject frequently of great perplexity to Weather Bureau officials is that of presenting meteorological data to the public in the most attractive manner. From the earliest days of the service maps and charts have been found, and still are, indispensable for illustrating graphically various sorts of atmospheric conditions and results, and it is hardly practicable to improve on these in any way, except as to higher grade of workmanship, finish, and color printing. But the introduction of the street shelter, or kiosk, opens up new possibilities and requirements in this direction; the exhibit of certain data to the public in the most simple and efficient manner being most desirable. The reading of graduated and figured scales is universally understood, and it is only necessary to take advantage of this fact in preparing such meteorological data as normal precipitation, temperature, etc.,—elements of interest to almost everybody. A plan for showing *rainfall* data, complete, by vertical scales is illustrated in the accompanying figure.

For this suggested scale we use simply any arbitrary system of graduated lines, of units and tenths, and number these in a series that will take in the range desired from zero (0) to and beyond the normal. A suitable adjustable pointer legend, *L*, at the top gives the average annual precipitation at the station from the commencement of observations, e. g., 43.50 inches, as

[2] E. Mascart: Journal de physique, 1879, p. 329-336.

[3] W. Köppen: Beiträge zur Kenntniss der Boen und Gewitterstürme. Ann. Hydrog. marit. Met., 1879, p. 324-335.

[4] I am of the opinion that the wind is not an ascending one outside and in front of the squall "zone" in those regions where no particular phenomenon has, as yet, been observed.—*J. Loisel.*

[5] M. Loisel here uses the term nimbus as it is used generally in Europe, and will be used during 1910 by United States Weather Bureau observers (see Instructions for preparing meteorological forms, 1910, par. 101-2).—*C. A., jr.*

[6] A. Turpain in La Nature, 1 mai, 1909.

shown in cut. On the left-hand side is a movable pointer, N, set daily to show *the normal to that date*, in this case indicating 8.28 inches; while on the right is a similar, adjustable, index, A, for the *actual* rainfall to date, set to indicate 7.25 inches, for example. Where permanent exhibits are installed, as now the case at some of the more important stations of the service, at expositions, within boards of trade, street kiosks, etc.,—the same people may frequently pass or examine the data daily. If not already somewhat familiar with meteorological apparatus they very quickly learn to read the instruments, charts, and maps, and with graphic scales of this character, a glance only is necessary to see how the *actual* and the *normal* compare from day to day, as shown by the relative positions of the sliding pointers.

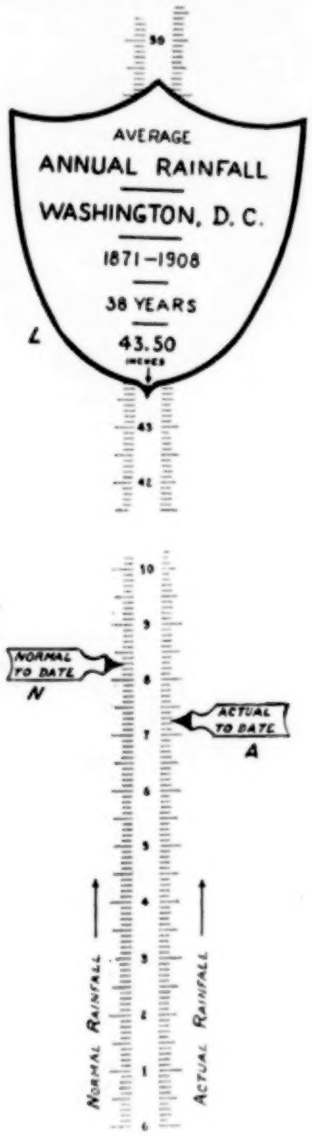

FIG. 1.—Meteorological display device (Maring).

Descriptive legends for conspicuous places such as the kiosks, should always be just as brief and concise as possible, so that even "he who runs" may read. To receive any attention from the average business man these legends should be in large type and in the fewest words; otherwise, he may not stop to read them at all. Increasing interest, however, is sure to develop from daily observations, and those who become especially interested in the subject can always obtain all the details required at the Weather Bureau offices.

In these days when advertising is an art, it is very desirable that the preparation and display of meteorological data be given every consideration, with a view to obtaining the best possible artistic effects, and, at the same time, educate the public to a better understanding of Weather Bureau work.

METEOROLOGICAL REGISTRATIONS IN SAMOA, 1902–1906. III. SUNSHINE.

By OTTO TETENS, Ph.D. Dated, Bensberg, Germany, May 13, 1909.

A Campbell-Stokes sunshine recorder was used, adapted to tropical conditions by mounting it on an adjustable board. During the first and last half-hours of the day the sheet-carrier shaded a part of the glass ball, thus shortening the registration by one hour on bright days. Furthermore the deepest part of the recording sheet was, by its concavity, able to collect some rain water which possibly prevented exact sunshine records once or twice about noon. Although the model used can not be recommended for a tropical station, still the records obtained can be reduced so that they are free from the defects of the instrument. Owing to the principal fault one hour was subtracted from the length of day in order to compute the true percentage of sunshine from the daily amount recorded. In the resulting percentage for days without clouds as known by eye observations 100 is given.

ANNUAL PERIOD.

Table 1 shows the monthly results for the years 1905 and 1906. During January, 1905, the recorder did not work satisfactorily, therefore the average percentage of the other five wet months of 1905 has been adopted for this month, the value has been placed in ( ).

TABLE 1.—*Insolation at Apia, Samoa*, 1905–1906.

Month.	Monthly.			Daily.	Average length of day.	Percentage of possible daily hours.		
	1905.	1906.	Average 1905–06.	Average 1905–06.		1905.	1906.	Average 1905–06.
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	%	%	%
January	(162)	**184**	(173)	(5.6)	12.7	(45)	51	(48)
February	128	147	137	4.9	12.4	40	46	43
March	146	167	156	5.0	12.0	43	49	46
April	155	181	168	**5.6**	11.7	48	**56**	52
May	**197**	146	**171**	5.5	11.4	**61**	45	**53**
June	173	121	147	4.9	11.2	56	39	48
July	140	158	149	4.8	11.2	44	50	47
August	144	144	144	4.7	11.5	44	44	44
September	176	**211**	194	6.4	11.9	54	**65**	59
October	**230**	194	**212**	**6.8**	12.3	**66**	56	**61**
November	170	158	164	5.5	12.6	49	45	47
December	157	153	155	5.0	12.8	43	42	42
Annual total	1978	1963	1970	5.4	12.0	49	49	49
Average.								
Dry month	177	162	170	5.5	11.6	54	50	52
Wet month	153	165	159	5.2	12.4	45	48	46

From these figures it is seen that the last two months of the dry season, September and October, show the largest percentage of sunshine, whereas the distribution of the higher and lower values in the other months seems quite irregular. For example, considering the average values of the two years, August (a dry month) shows below 50 per cent of its possible, April (a wet month) above 50 per cent of possible sunshine. The months of May and June present the largest differences between the two years. This is in agreement with the character of these two months as determined by the rain observations.

Mean cloudiness.—For several places the mean cloudiness of the month, d, has been computed from the monthly number of clear, s, and cloudy, c, days, using the formula:

$$d=a+b\,.\,\frac{c-s}{n}\,,$$

c = the number of days per month with 25 per cent or less sunshine,

s = the number of days per month with 75 per cent or more sunshine,

n = the number of days per month.

The statistics of the clear and cloudy days are given in Table 2, which presents, in addition, the number of days without any sunshine, or overcast days, *o*.

TABLE 2.—*Number of clear, cloudy, and overcast days, Apia, Samoa, 1905–6.*

Month.	1905.			1906.		
	s.	*c.*	*o.*	*s.*	*c.*	*o.*
January	6	10	3	8	6	1
February	3	10	3	5	9	1
March	7	11	4	8	10	5
April	8	9	4	11	5	2
May	14	5	1	6	8	2
June	8	5	2	4	9	3
July	7	9	1	6	5	2
August	6	9	1	5	9	2
September	9	4	0	17	4	0
October	15	3	0	11	6	2
November	7	10	4	8	9	4
December	3	10	2	2	11	3
Year	93	95	25	91	91	27
Average.						
Dry month	10	6	1	8	7	2
Wet month	6	10	3	7	8	3

The mean cloudiness has been derived according to the usual scale of 0 to 10 from the percentage of sunshine, *p*, using the formula

$$p+10\,d=100.$$

Thus, by the method of least squares, from the single monthly values of *s*, *c*, and *d* the following results for the coefficients *a* and *b* have been derived:

$$a=5.07,\ b=3.70.$$

It has been found that for Germany $a=5.1$ and $b=5.0$; therefore, the fluctuations of $c-s$, corresponding to certain fluctuations of *d*, are much larger in Samoa than they are in Germany.

The foot of Table 2 shows that in both years the average dry month embraced exactly as many clear days, as the average wet month embraced cloudy ones, and vice versa. Consequently in considering the annual amounts, the clear days appear as often as the cloudy ones, each being about 25 per cent of all days, i. e., exactly the percentage of degrees of sunshine embraced by the two classes according to their definition. This very even distribution of the different grades of cloudiness seems to be a remarkable feature of the climate of Samoa.

The annual number of days without any sunshine is about 26, or 7 per cent of all days. During the wet season the percentage is 10 and during the dry season only 4.

DAILY PERIOD.

In considering the average values for 1905–6 in the majority of the months the maximum sunshine occurs during the morning hours from 9^a–12^a, except the months of January (10^a–1^p), February (8^a–9^a), and May (12^a–1^p). The average maximum hour for the year as well as for the two seasons is from 10^a–11^a; this can be seen from Table 3.

TABLE 3.—*Average hourly percentages of sunshine, Apia, Samoa, 1905–6.*

Hours ending	Year.	Seasonal.	
		Dry.	Wet.
	%	%	%
7 a. m	10(19)	6(19)	14(20)
8 a. m	42	35	48
9 a. m	57	58	57
10 a. m	62	64	60
11 a. m	63	65	62
12 m	62	65	58
Sum, a. m	**296**	**293**	**299**
1 p. m	60	62	57
2 p. m	54	58	51
3 p. m	49	52	46
4 p. m	42	46	38
5 p. m	32	34	29
6 p. m	9(18)	8(28)	10(14)
Sum, p. m	**246**	**260**	**231**
Difference a. m.−p. m	50	33	68

Regarding the figures for the hours ending 7 a. m. and 6 p. m., when compared with different months or seasons, or in comparison with the other hours of the day, it must be remembered that even on cloudless days the sunshine can be recorded only during a part of these hours. The maximum possible sunshine for these hours varies with the day's length from January (0.86 hour), June and July (0.12 hour), to December (0.90 hour). The average for the year is 0.50, for the dry months 0.29, and for the wet months 0.69 hour. When the mean cloudiness is to be computed from the hourly sunshine percentage, the figures for the two hours mentioned have to be divided by these fractions according to the different months of seasons. In Table 3 the figures thus obtained are added in curves. Thus during the wet season the sunshine of the early morning hours predominates a little over the dry season. Evidently during the wet months the higher altitude of the sun from 7 to 8 a. m. helps the sun to overcome the absorption produced by the lower strata, while in the dry season the sunshine predominates in the evening hours.

The diurnal maximum of sunshine is in accordance with the diurnal minimum of rain, which in Samoa occurs from 12 to 1 p. m. during the dry season, and during the wet season from 10 to 11 a. m. (quantity and intensity of rain), or 11 to 12 a. m. (duration of rain). Generally, the time of the diurnal rain minimum is a little later than the sunshine maximum. The total amount of forenoon sunshine of every month is greater than that of the afternoon. The months of May and June show a slight difference, but February and December more than one hour. The difference for the two seasons as well as for the year is given at the foot of the table, the average for the year is 0.50 hour.

THE SEASONS AND THE MEAN DAILY MINIMUM AT MEXICO, MO.

By GEORGE REEDER, Section Director. Dated Columbia, Mo., September 23, 1909.

It seems never to have been definitely determined upon what temperature the seasons depend, that is, at what temperature and corresponding date does spring open? When is the flood time of summer? the opening of autumn? the beginning of and the minimum cold of winter? Some writers[1] say that spring begins when the temperature reaches 44° F., but this does not seem to correspond to any distinct epoch in biological phenomena. As a rule, Nature's signs are well advanced before we begin to take notice of them. "The sap has begun to run," insect life is stirring, the brown sod is showing green, and then we say that spring is here. But the processes of life had already renewed their activity before these signs appeared; at just what time does that "mysterious touch of Nature" take place in the early spring?

A study of the mean annual or normal temperature of a place gives no satisfactory answer to this query, but the mean daily temperatures and particularly the mean daily minima present very interesting features. The present paper presents graphically in figs. 1 to 4, the results of the daily maximum and minimum temperatures recorded at Mexico, Audrain County, Mo., during the thirty years 1878 to 1907. A similar study and compilation for the seventeen years of records at Columbia, Boone County, Mo., gave results that agree in all essential points, but the daily irregularities are of course less marked in the means from the longer record at Mexico. The same figures present graphically the arithmetical sums of the rainfalls on each day for the whole thirty years.

In Missouri the seasons are particularly well marked, and both Mexico and Columbia afford very satisfactory points for

[1] Hann defines "winter days" as those days on which the temperature does not rise above freezing even in the afternoon, and "summer days" as those on which the afternoon temperature reaches or exceeds 25° C. (77° F.) (Hann-Ward: Climatology, p. 28). According to this definition, Mexico Mo., has but few winter days, if any.—*C. A., jr.*

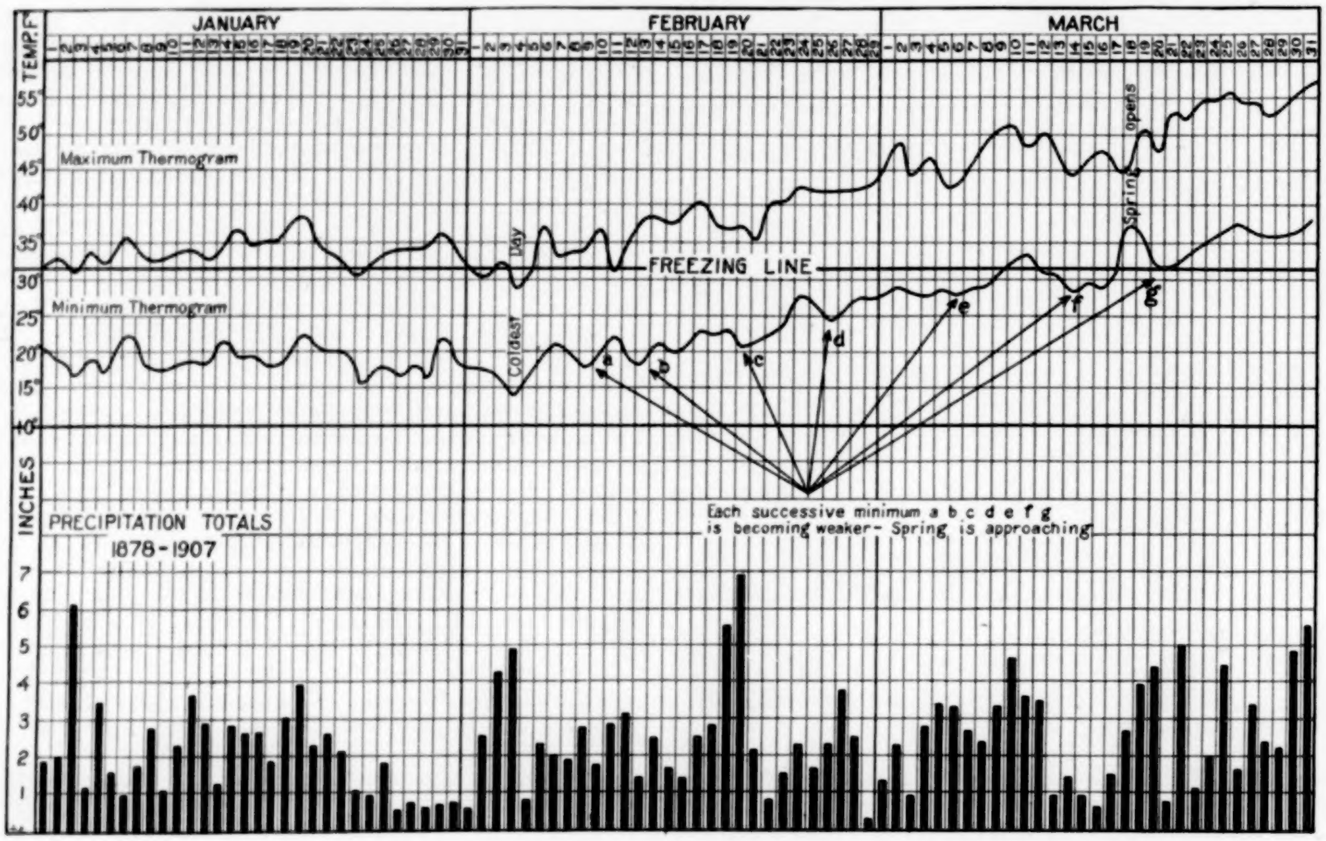

FIG. 1.—Average daily maximum and minimum temperatures, and daily precipitation totals, Mexico, Mo., 1878-1907. (January-March).

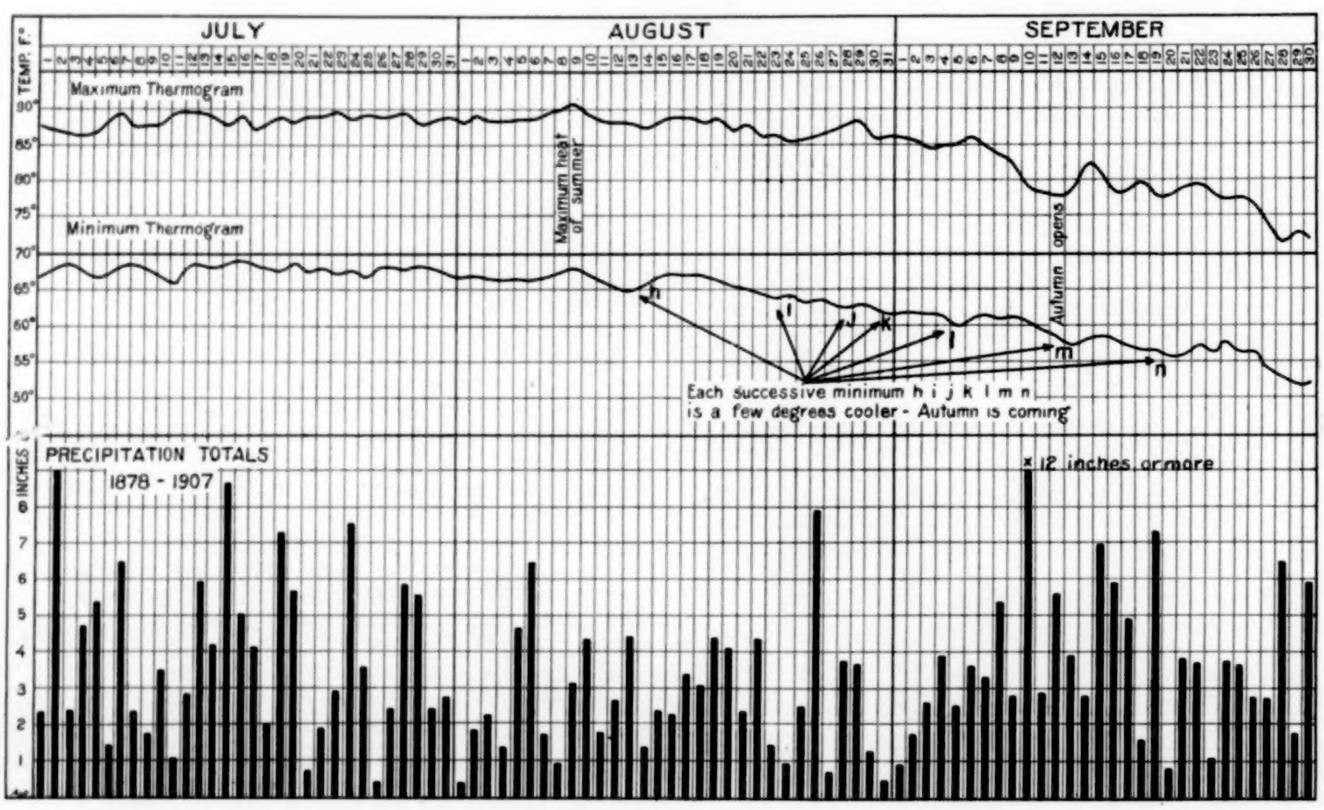

FIG. 3.—Average daily maximum and minimum temperatures, and daily precipitation totals, Mexico, Mo., 1878-1907. (July-August).

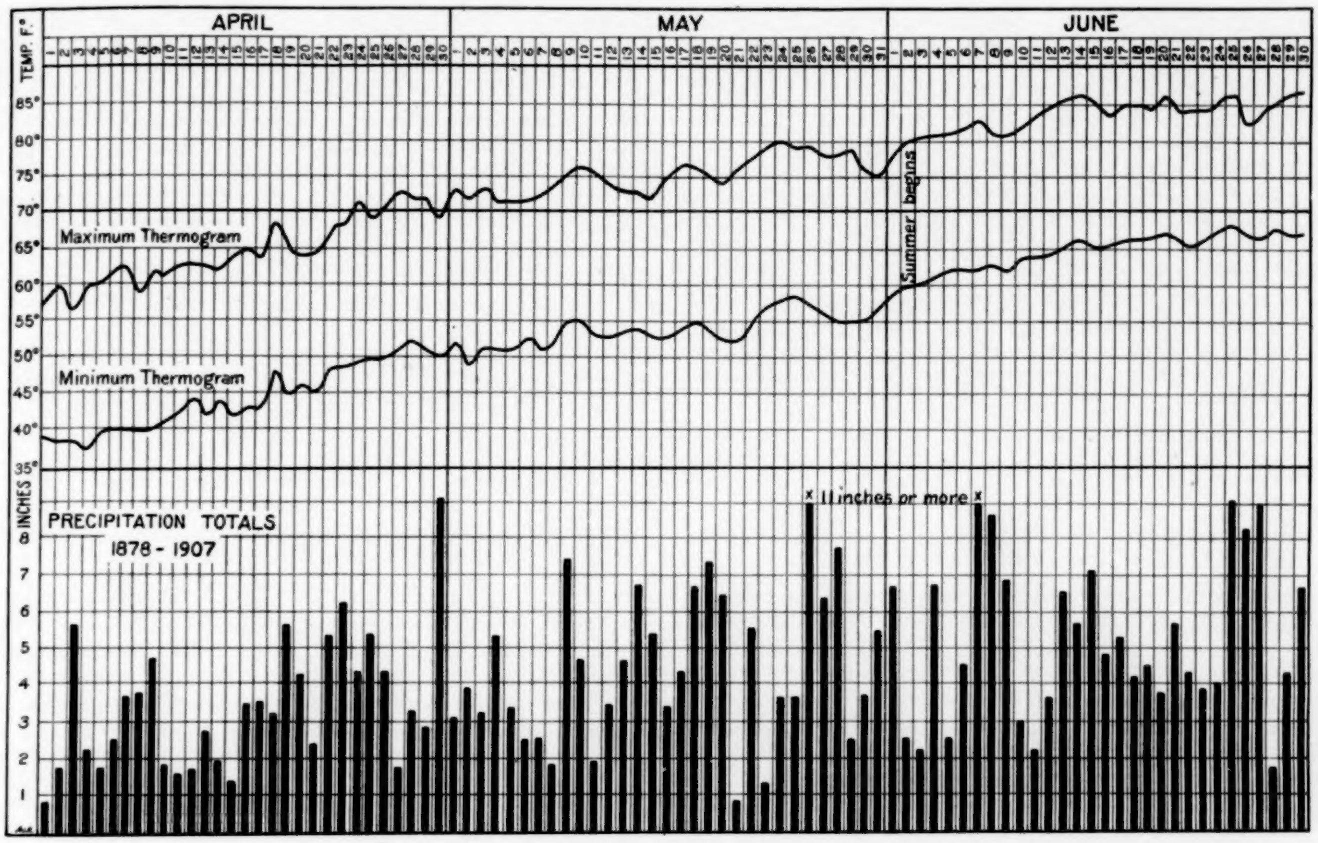

FIG. 2.—Average daily maximum and minimum temperatures, and daily precipitation totals, Mexico, Mo., 1878-1907. (April-June).

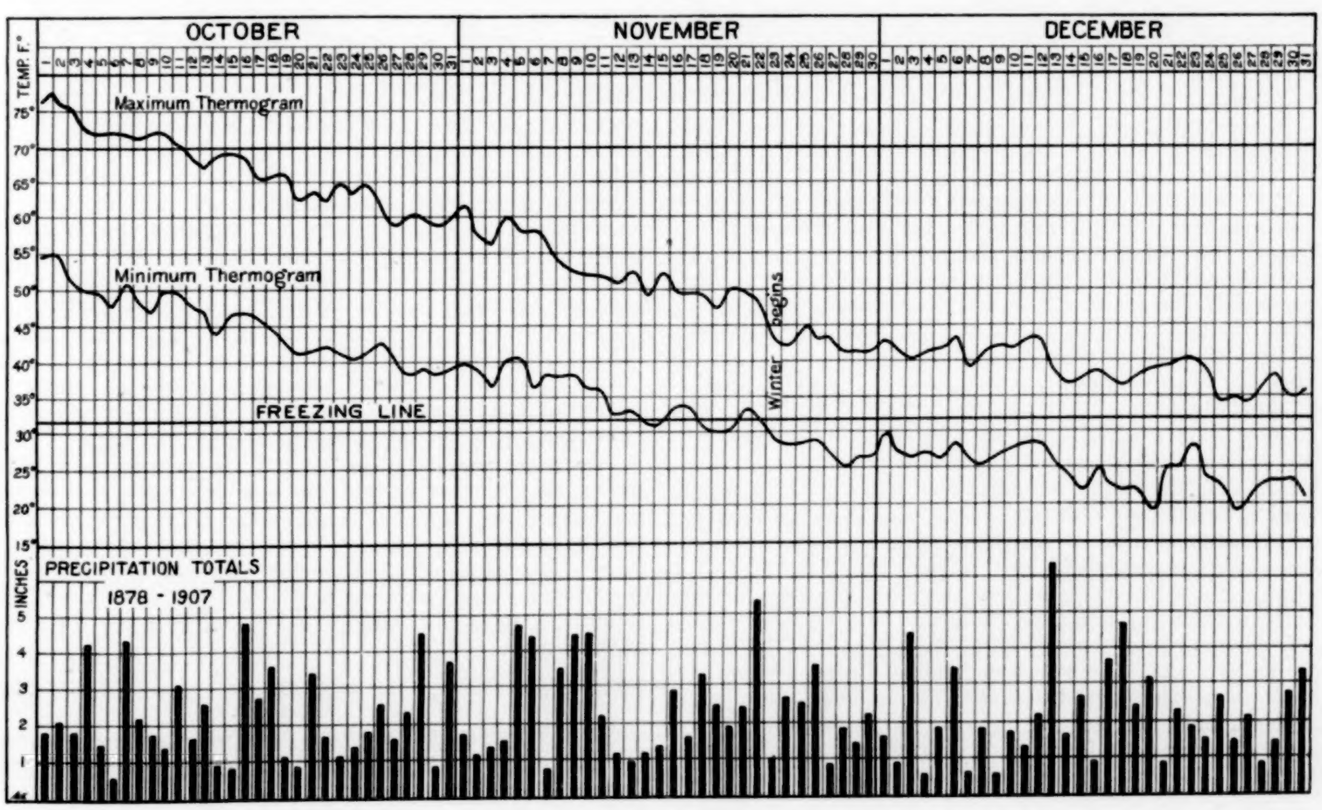

FIG. 4.—Average daily maximum and minimum temperatures, and daily precipitation totals, Mexico, Mo., 1878-1907. (October-December).

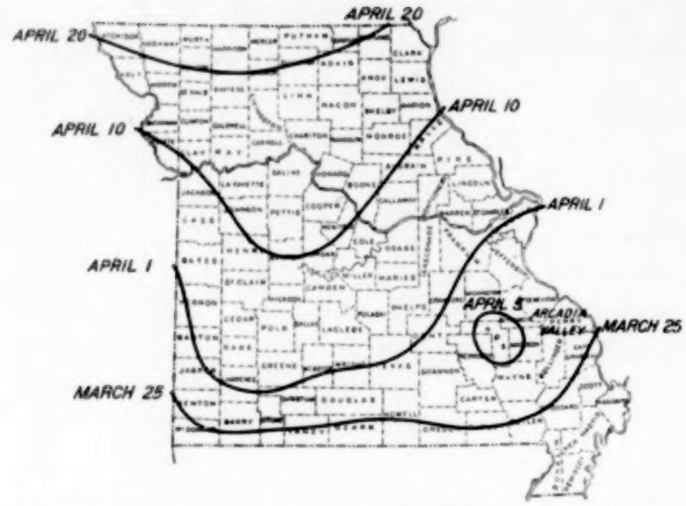

FIG. 5.—Average date of the first leafing of the soft maple in Missouri. (Four years, 1904-1907, observations).

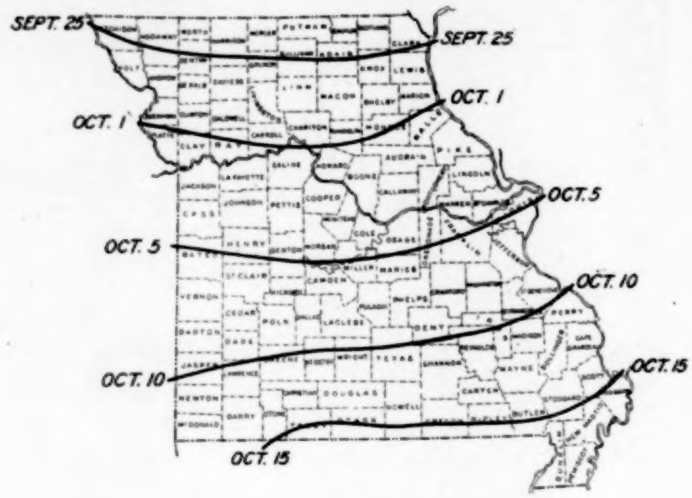

FIG. 6.—Average date on which the forests begin to assume autumn colors in Missouri. (Four years' observations).

observations which are calculated to develop the seasonal temperature fluctuations in the layers of the atmosphere and the earth which are nearest each other. One may observe that the thermograms of the average maximum and average minimum temperatures clearly indicate that for Mexico, Mo., the coldest day of winter is February 4. Immediately after that date both curves begin their ascent, indicating that the layers of earth and air in contact begin to receive more heat than they lose by radiation. Each successive drop in the minimum curve, occurring every four to six days, is a little weaker than the preceding one, for spring is approaching.

Is it possible for vegetal and insect life to awaken while the average daily minimum temperature remains below 32° F.? One may often experience a warm, spring-like day during the latter part of February and the first of March, but no insect seems to be stirring. Now we find that the curve of the average minimum first rises above 32° on March 10 (see fig. 1), but the writer does not believe that may be properly called the opening day of spring, for the curve continues below the freezing temperature line for a whole week longer. On the 18th, however, it finally rises and remains above the 32° line, and this date is evidently the opening day of spring, when that "first mysterious touch of Nature" takes place. While March 18 may mark the awakening, there is very little to indicate the phenomenon at this time, as all life seems yet dormant; but "the sap begins to run," and some time between April 8 and 12 the soft maple, which is an early variety, begins to put forth its first leaves. The progress across Missouri of this spring awakening of the soft maple is strikingly and clearly shown by the date lines of fig. 5.

The spring weather of Mexico, Mo., its many variations from warm to cool, sunshine to showers, is interestingly shown by fig. 2, which also shows the increasing stability of the weather as summer approaches. We have taken June 2 as the first day of summer because that is the first day on which the mean daily temperature reaches 70° and remains above it.

The astronomer informs us that the longest day of the northern [astronomical] summer is June 21, when the sun rises farthest in the north and sets farthest in the north. But it is generally known that the greatest heat of summer does not occur until some time after this date. The flood time of summer has never been, heretofore, definitely pointed out. Some observers have gone so far as to say that summer begins to wane in July, but this can not be true of Mexico, Mo., nor indeed of the central and greater portion of the United States. Summer can not wane before the maximum heat has been attained. About fifty days after the summer solstice, or the longest day of the northern year, i. e., about August 8 or 9, we reach the flood time of summer. The full flood of summer may be said to continue from July 15 to August 9, but it appears from fig. 3 that the maximum heat is attained on August 9 at Mexico, Mo. This figure shows clearly the steadily high temperatures from about July 15 to August 9, and that almost immediately following the latter date the ebb begins.

Both the maximum and the minimum thermograms, but more particularly the minimum, show clearly how the earth now begins to lose more heat by radiation than it received during the day. At each successive change the temperature curve drops a little lower than at the preceding change; the changes take place slowly for the first fifteen or twenty days, then the magnitude of the successive drops increases very noticeably. We plainly see "the signs of a dying year." And thus we approach the opening day of autumn, which I put at or about September 12 for the locality under discussion. Some fifteen or twenty days later we see the forests beginning to assume their autumn colors. As fig. 6 shows, this change is first noticed in the northern part of the State about September 20 and, reversing the direction of the march of the first leafing shown in fig. 5, sweeps slowly southward across the whole State, occupying about a month in its passage.

Our minimum thermogram, fig. 4, shows that winter begins at Mexico, Mo., on November 23, when the average daily minimum falls below 32° and stays there. Quite a month later the days are the shortest and the hours of darkness are the longest, but the winter cold does not reach its minimum until February 4, or about forty-five days after the winter solstice.

The curve of the average minimum temperatures shows that spring, as here defined, is made up of 77 days, summer of 101 days, autumn of 72 days, and winter of 115 days.

The total precipitation for the thirty years, 1878-1907, is shown day by day in figs. 1 to 4, which bring out clearly the rainfall of the different periods, the increase from winter to spring and summer, and the decrease to autumn again. The days of the years which have the heaviest rainfalls or are most frequently rainy are readily picked out since they have the tallest columns, i. e., have the greatest totals for the whole thirty years.

ICE CONDITIONS ON THE GREAT LAKES, WINTER OF 1908-09.[1]

By N. B. CONGER, Inspector and Marine Agent. Dated Detroit, Mich., July 14, 1909.

On account of the comparatively mild winter in the Lake region there was less ice reported in all of the lakes. The

[1]Similar details as to ice in the Great Lakes for the winters of 1899-1907 will be found in the Lake Charts for those years, published semiannually by the Weather Bureau, also in Monthly Weather Review, August, 1908, 36:239-244, and May, 1908, 36:137-140.

thickness was not as great as the previous season. In Superior the fields apparently shifted freely with the winds and more extensive fields appeared over the eastern portion during the latter part of March. In Michigan the main fields were confined to the extreme northeastern portion from the islands northeast to the straits. During about ten days in March there was a small field over the extreme southeast portion of the lake. At the straits the ice attained a thickness of 20 inches, which is 2 inches thicker than last winter, but it was not windrowed. While vessels forced a passage through the ice on April 14, 1909, the ice did not disappear until April 28, 1909. In Huron there were no heavy or extensive fields reported during the winter. Over the extreme southern portion the field was intact for only about ten days in March. The ice did not impede navigation and there was not a heavy run into the St. Clair River. The ice in Lake St. Clair was not heavy at any time during the winter and was broken up and ran out early in March. Over the western portions of Erie, except around the islands, the ice disappeared early in March. The shifting winds moved the ice fields, so that there appeared more extensive fields over the eastern portion during the last two weeks of March than occurred during the previous season. These fields were not heavy and were easily broken up. As is usual, on account of prevailing southwest winds, the field was driven to the extreme eastern portion of the lake, gradually disappearing. The last ice was reported at Buffalo on April 28, 1909. The disappearance of ice this year was about eleven days earlier than of the season of 1908. The fields in Ontario were not heavy. They disappeared over the western portion early in March, and over the extreme eastern portion the ice was reported as late as April 7, 1909.

TABLE 1.—*The closing and opening of navigation, and the ice conditions on the Great Lakes during the winter of 1908–9.*

LAKE SUPERIOR.

Stations.	Navigation.		Ice first formed.	Greatest thickness.	Ice disappeared.	Remarks.
	Closed.	Opened.				
		1909.		*Inches.*	1909.	
Duluth, Minn	Dec. 10, 1908	Apr. 11	Dec. 1, 1908	29.0	Apr. 7	Local navigation closed January 16, 1909. There was a considerable field of ice along the south shore after it had disappeared in Duluth Harbor.
Allouez, Wis	Dec. 8, 1908	Apr. 22	Dec. 1, 1908	20.0	Apr. 22	
Two Harbors, Minn	Nov. 28, 1908	Apr. 11	Dec. 1, 1908	4.0	Mar. 23	Fish tugs kept the harbor open and made trips between this port and Grand Marais, Ont., until February 2, 1909.
Bayfield, Wis	Jan. 1, 1909	Apr. 23	Jan. 10, 1909	30.0	May 7	Ice became impassible for teams about April 10, 1909.
Washburn, Wis						Ice began breaking up about April 13, 1909.
Ashland, Wis	Dec. 5, 1908	Apr. 24	Dec. 5, 1908	27.0	May 7	The steamer *Charles O. Jenkins* broke her way into the harbor on April 23 and 24, 1909.
Ontonagon, Mich	Dec. 6, 1908		Nov. 1, 1908	22.0		Harbor not closed by ice until January 25, 1909.
Ship Canal, Mich	Dec. 9, 1908	May 4	Nov. 28, 1908	12.0	Apr. 15	But a small amount of broken ice in the canal and harbor after April 13, 1909.
Eagle Harbor, Mich	Dec. 17, 1908	Mar. 30	Jan. 15, 1909	14.0		
Houghton, Mich	Dec. 7, 1908	May 4	Dec. 3, 1908	17.0	May 10	Navigation opened through the lower entry (Big Portage) on May 6, 1909.
Marquette, Mich	Dec. 5, 1908	Apr. 21	Jan. 1, 1909	10.5	Apr. 20	The ice field extended beyond vision on March 9, and remained practically unchanged until about April 10, 1909.
Grand Marais, Mich	Dec. 12, 1908		Nov. 30, 1908	28.0	May 5	Harbor ice broken up and moving out April 13 and Lake Superior practically clear of ice off this port on same date.
Whitefish Point, Mich.	Dec. 15, 1908					Whitefish Bay froze over February 12, 1909, and remained solid until about April 6. The eastern end of the bay and the lake off this port practically clear of ice on April 11, but ice fields drifted in after this date.
Sault Sainte Marie, Mich	Dec. 13, 1908	Apr. 20	Dec. 4, 1908	19.0		Harbor ice broke and running except behind canal piers on April 8, but upper end of river still solid; the St. Marys River began breaking up about April 13, and a passage was forced on April 20, The first up bound passage through the American lock was steamer *G. W. French* at 7:30 p. m. April 20, and through the Canadian lock was steamer *Paliki* at 7:05 a. m. April 21. The first down bound through the American lock was steamer *Northern Queen* at 4:38 p. m. April 26, and through the Canadian lock was steamer *Carleton* at 5:10 p. m. on same date.

LAKE MICHIGAN.

Stations.	Closed.	Opened.	Ice first formed.	Greatest thickness.	Ice disappeared.	Remarks.
Gladstone, Mich	Dec. 5, 1908	Apr. 19	Dec. 3, 1908	21.0		Ice covered with about 10 inches of snow most of season.
Escanaba, Mich	Dec. 20, 1908	Apr. 19	Dec. 22, 1908	25.0		Considerable ice remained in the upper bay when navigation opened.
Menominee, Mich	Jan. 2, 1909	Apr. 22	Dec. 1, 1908	17.5		The tug *Satisfaction* reached Menominee from the east shore at noon April 22, after a hard fight with floating ice.
Green Bay, Wis	Dec. 7, 1908	Apr. 14	Dec. 2, 1908	12.0	Apr. 24	The river began breaking on April 20, 1909. The ice on Green Bay was broken up by northwest gale on April 7, but did not move out at that time.
Sturgeon Bay, Wis	Jan. 1, 1909	Mar. 28	Dec. 2, 1908	18.0	Apr. 24	Navigation through to Green Bay closed December 15, 1908, and the car ferry *Ann Arbor No.* 3 broke her way through the ice en route from Menominee to Ludington on April 14, 1909.
Kewaunee, Wis			Nov. 20, 1908	3.0		Navigation has remained open throughout the winter; but two or three inches of ice formed at any time would be broken up by steamers making this port, and would then drift out into the lake.
Manitowoc, Wis			Nov. 14, 1908	15.0	Mar. 30	Navigation has remained open throughout the winter; and what ice formed in the harbor was broken up by the car ferries and it soon drifted out into the lake. The ice in the river above the Wisconsin Central Railway slip formed to a thickness of 15 inches.
Sheboygan, Wis	Dec. 19, 1908		Jan. 5, 1909	3.5		Practically no ice in the harbor as fish tugs have kept it open. Ice fields were drifted in and out of the bay by the wind.
Milwaukee, Wis	(Dec. 16, 1908)					Several lines of steamers make this port regularly throughout the year but general navigation (interlake) closed about December 16, 1908. Very little ice formed inside the breakwater but the harbor was filled with slush ice, which drifted in and out with the wind, from February 14 to 24 and from March 16 to 21.
Racine, Wis						This port open for navigation throughout the year.
Kenosha, Wis						This port open for navigation throughout the year.
Chicago, Ill						This port open for navigation throughout the year. Floating ice has been very constant during the winter although seldom in great quantity. During the northeast gale of February 18 and 19 floating fields of considerable size were observed and smaller fields were constant until March 2.
Michigan City, Ind	(Dec. 15, 1908)		Dec. 5, 1908	8.0	Mar. 9	General navigation closed about December 15, 1908 but the harbor has been practically clear of ice except when field ice was drifted in from the lake.
St. Joseph, Mich	(Dec. 18, 1908)		Jan. 1, 1909	6.0		The harbor has been open practically all winter except when closed by drifting fields of ice from the lake.
South Haven, Mich	Jan. 1, 1909	Mar. 9	Dec. 31, 1908	4.0	Mar. 30	There has been but little ice in the harbor during the winter and but few ice fields have been observed in the lake.
Holland L. S. S., Mich	Dec. 24, 1908	Mar. 9	Jan. 1, 1909	5.0	Mar. 25	Few ice fields have been observed off this port.
Grand Haven, Mich			Jan. 11, 1909	2.0		Navigation remained open all winter at this port and during the past winter it has been impeded but slightly by ice.
Muskegon, Mich				8.0	Mar. 14	The harbor has been open most of the winter. Ice in Muskegon Lake formed to about 5 inches.
Pentwater, Mich	(Dec. 31, 1908)		Jan. 7, 1909	12.0	Apr. 13	Fish tugs continued to operate until January 8, 1909. But little field ice has been observed off this port during the past winter.
Ludington, Mich		(Mar. 9)	Dec. 10, 1908	11.0		The harbor was partially frozen over but navigation has been open all winter. Fish tugs began operations March 9, 1909.
Manistee, Mich	Dec. 18, 1908	Mar. 27	Dec. 9, 1908	14.0	Apr. 6	The maximum thickness of ice in the harbor was about 8 inches.
Frankfort, Mich			Dec. 4, 1908	14.0		The car ferries have kept this harbor open all winter.
Glen Haven, Mich	Dec. 7, 1908[a]	Mar. 27[b]				There has been practically no ice off this port during the past winter.
South Manitou, Mich						There has been but little ice on the beach. This port has been open to the mail and fish boats all winter.
Harbor Springs, Mich	Dec. 14, 1908	Apr. 15	Jan. 1, 1909	15.0	Apr. 20	A field of ice about 7 miles wide lay off this port during most of March, 1909.
St. James, Beaver Island, Mich	Jan. 15, 1909[a]	Mar. 26[b]		15.0	Mar. 29	
Mackinaw, Mich	Dec. 13, 1908[a]	Apr. 14[c]	Dec. 2, 1908	20.0	Apr. 28	Much less ice than usual in the Lake Michigan entrance to the "Straits".

[a] Last departure. [b] First arrival. [c] First departure.

LAKE HURON.

Stations.	Navigation. Closed.	Navigation. Opened.	Ice first formed.	Greatest thickness.	Ice disappeared.	Remarks.
		1909.		*Inches.*	1909.	
Mackinac Island, Mich.	Dec. 13, 1908	Apr. 14	Dec. 27, 1908	14.0	Apr. 28	Navigation between the island and mainland did not close until February 11, 1909 and the mail steamer reached the dock from St. Ignace on April 2, 1909.
Detour, Mich.	Dec. 20, 1908	Apr. 19	Dec. 16, 1908	10.0	....	Four steamers reported stuck in the ice between Sweets Point and Lime Island. The ice in St. Marys River forced April 20, 1909.
Cheboygan, Mich.	Dec. 23, 1908	Apr. 14	Jan. 12, 1909	8.0	Apr. 13	Fish tugs operated until January 3, 1909. Harbor free of ice on April 6, 1909 and no ice south of the light-house.
Presque Isle, Mich.	Dec. 15, 1908	Apr. 14	Dec. 1, 1908	29.0	Apr. 10	Harbor full of broken ice and many ice fields, drifting with the wind, off this port during March 1909.
Middle Island, Mich.	Dec. 15, 1908	Apr. 14	Dec. 2, 1908	5.0	Mar. 30	Ice fields not as extensive as former winters and the ice was not so thick. A few floating pieces of ice visible April 13, 1909, in the lake.
Thunder Bay Island, Mich.	Dec. 13, 1908	Apr. 14	Dec. 2, 1908	6.0	Mar. 23	Very little ice has formed around this island as compared with former years.
Alpena, Mich.	Dec. 8, 1908	Mar. 28	Dec. 12, 1908	12.0	Mar. 23	Fish tugs began setting their nets March 11, 1909. Thunder Bay clear of ice March 23, 1909.
Oscoda, Mich.	Nov. 28, 1908	....	....	....	....	Only few fields of ice observed off this port during the past winter and they have not been of sufficient thickness to obstruct the movements of fish tugs.
Tawas Point L. S. S., (East Tawas), Mich.	Dec. 12, 1908	....	Nov. 15, 1908	13.0	Apr. 13	Ice formed over the bay during the early part of the winter but was broken up and driven out by northeast gale on January 29, 1909.
Bay City, Mich.	Dec. 5, 1908	Apr. 18	Dec. 3, 1908	12.0	Apr. 6	Saginaw River clear of ice March 30, 1909. Tug *Arthur Jones* cleared for Buffalo on April 18, 1909.
Point aux Barques, Mich.	Dec. 9, 1908	....	Jan. 6, 1909	10.0	Apr. 6	Ice field did not exceed 3 miles in width during the past winter.
Harbor Beach, Mich.	Nov. 20, 1908	....	Dec. –, 1908	8.0	Mar. 30	But few fields of ice visible off this port as compared with former years.
Port Huron, Mich.	Dec. 16, 1908	Mar. 29	Dec. 5, 1908	10.5[d]	Mar. 26	A large field of ice was observed at the mouth of the lake March 23, 1909 but most of it was blown back up the lake and did not pass down the river.

[d] Measured in Black River.

DETROIT RIVER.

Stations.	Navigation. Closed.	Navigation. Opened.	Ice first formed.	Greatest thickness.	Ice disappeared.	Remarks.
Detroit, Mich.	Dec. 14, 1908	Mar. 29	Dec. 8, 1908	8.0	Mar. 23	The ice in Lake St. Clair was broken up by warm wave January 25, 1909. Heavy snow and some slush ice retarded the ferries somewhat on February 16 and 17, 1909. On March 7 the steamer *Pleasure* made a trip to Bois Blanc and reported no ice encountered. A channel from Lake St. Clair to Lake Erie was open on March 15, 1909. Navigation was opened by the steamer *City of Detroit* on March 29, to Cleveland, and the steamer *W. J. Carter* passed down same day.

LAKE ERIE.

Stations.	Navigation. Closed.	Navigation. Opened.	Ice first formed.	Greatest thickness.	Ice disappeared.	Remarks.
Toledo, Ohio	Dec. 14, 1908	....	Dec. 9, 1908	5.5	Mar. 9	Maumee River cleared of ice February 24, 1909; very little ice in Maumee Bay after this date.
Put-in-Bay, Ohio	Jan. 1, 1909	Mar. 23	Jan. 15, 1909	6.0	Mar. 27	The ice around the islands was broken up on March 16 and a steamer could have easily reached the landings by March 23, 1909.
Kelleys Island, Ohio	Dec. 31, 1908	Mar. 10	Dec. 20, 1908	8.0	Mar. 27	
Marblehead, Ohio	Dec. 15, 1908	Mar. 10	Jan. 1, 1909?	4.0	Mar. 23	Ice fields off this port were not as heavy as usual.
Sandusky, Ohio	Dec. 28, 1908	Mar. 10	Dec. 8, 1908	5.0	Mar. 23	Sandusky Bay was clear of ice on March 8, 1909.
Huron, Ohio	Dec. 11, 1908	....	Dec. 10, 1908	5.0	Mar. 16	Harbor practically clear of ice March 2, and no ice observed in the lake after March 16, 1909.
Lorain, Ohio	Dec. 10, 1908	....	Jan. 12, 1909	3.0	Mar. 9	No ice in the lake off this port after March 16, 1909.
Cleveland, Ohio	Dec. 11, 1908	Mar. 29	Jan. 2, 1909	4.0	Mar. 26	No ice in the lake off this port after March 23, 1909.
Ashtabula, Harbor, Ohio	Jan. – 1909	Mar. 30	....	7.0	Mar. 30	This port was practically open for navigation except for two weeks in the latter part of March when northerly winds drove a heavy field into the harbor. Fishing tugs were operating with very little difficulty on March 30, 1909.
Conneaut Harbor, Ohio	Feb. 5, 1909	Mar. 8	Jan. 1, 1909		Apr. 2	A large ice field driven in by the wind, prevailed off this port for about two weeks during the latter part of March.
Erie, Pa.	Dec. 19, 1908	Apr. 1	Nov. 4, 1908	4.5	Apr. 6	The ice fields off this port were not as extensive nor as thick as usual.
Dunkirk, N. Y.	Dec. 31, 1908	....	Dec. 23, 1908	4.5	Apr. 13	
Buffalo, N. Y.	Dec. 28, 1908	Apr. 16	Dec. 23, 1908	6.0	Apr. 26	Navigation closed by departure of the steamer *Davidson* on December 28, 1908. There was no ice in the harbor after April 9. The ice in this end of the lake was broken up by the gale of April 7 and gradually passed down the river until April 26, 1909.

LAKE ONTARIO.

Stations.	Navigation. Closed.	Navigation. Opened.	Ice first formed.	Greatest thickness.	Ice disappeared.	Remarks.
Fort Niagara, N. Y.	Dec. 6, 1908	....	Dec. 22, 1908	6.0	Apr. 27	No ice in this vicinity on March 30, but considerable came down the Niagara River after this date and the river was blocked on April 13, 1909.
Charlotte, N. Y.	Dec. 3, 1908	(Mar. 9?)	Jan. 7, 1909	4.0	Mar. 9	
Sodus Point, N. Y.	Dec. 9, 1908	Mar. 25	Dec. 9, 1908	12.0	Mar. 25	All ice cleared from the harbor on the afternoon of March 25 and none visible in the lake after March 9, 1909.
North Fair Haven, N. Y.	Dec. 6, 1908	Mar. 26	Dec. 10, 1908	11.0	Apr. 6	Some ice remained in the coves, but there was no ice visible in the lake after March 2, 1909.
Oswego, N. Y.	Dec. 7, 1908	Apr. 10	Dec. 6, 1908	8.0	Mar. 11	There has been practically no ice in the lake during the winter; the steamer *Hinckley* was setting buoys on April 6; and the steamer *Cornelia* arrived from Kingston on April 10, 1909.
Sacketts Harbor, N. Y.	Dec. 20, 1908	....	Jan. 2, 1909	9.0	Apr. 13	Black River and the harbor began breaking up on April 6, 1909.
Cape Vincent, N. Y.	Jan. 8, 1909	Apr. 7	Dec. 25, 1908	12.0	Apr. 13	The gale of April 7 cleared the harbor of ice and the steamer *Pierrepont* arrived from Kingston on that date.
Ogdensburg, N. Y.	Dec. 20, 1908	....	Dec. 15, 1908	16.0	Mar. 30	The river free of ice below the light-house on March 2, but above it remained solid until late in March.

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——

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RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. Fitzhugh Talman, Librarian.

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O kolebaniíakh klimata Evropeĭskoĭ Rossii v istoricheskiu épokhu. Moskva. 1908. 107 p. 4°. [On fluctuations in the climate of European Russia during historic times.]
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48th annual volume. London. 1909. 100 [304] p. 8°.

Bulgaria. Central meteorological institute.
Bulletin sismographique ... no. 4. Enregistrements à Sofia du 1 janvier au 30 juin 1909. 24 p. 8°.
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... Three typhoons in Luzon October 4 to 13, 1908. Manila. 1909. 43 p. 4°. (Reprint from the Bulletin of the Philippine Weather bureau for October, 1908.)

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Die Erdbebenwarte. (Sonderabdruck aus der Festschrift zum 500-jährigen Jubiläum der Universität Leipzig. 6 p.)

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Bd. 3. Meteorologie. I[er] Teil. Meteorologische Ergebnisse der Winterstation des "*Gauss*" 1902-1903 von Wilhelm Meinardus. Berlin. 126 p. f°.
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Deutsche überseeische meteorologische Beobachtungen. [Hamburg. 1909.] vi, 76 p. f°.

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4th annual report ... 1909.] London. 1909. 140 p. 8°.

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Le Congo. Géographie physique, politique et économique. 2[me] éd. revue et mise à jour par George Morissens. Bruxelles. [1908.] viii, 502 p. 8°.

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... Schätzung der mittleren Niederschlagshöhe im Grossherzogtum Hessen ... 1907. (Sonderabdruck aus dem Notizblatt des Vereins für Erdkunde und der Grossh. geol. Landesanstalt zu Darmstadt. 4. Folge. Heft 29. 1908. p. 147-149.)

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Memorandum on the monsoon conditions prevailing during June and July, with anticipations for August and September, 1909. Simla. 1909. 5 p. f°.

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... Ueber Gewitterperioden in der Schweiz. Frauenfeld. [1909.] 55 p. 4°. (Beilage zum Programm der Thurgauischen Kantonsschule für das Schuljahr 1908-09.)

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Deutsches meteorologisches Jahrbuch 1908. 8. Jahrg. Darmstadt. 1909. 59 p. f°.

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Meteorological observations ... 1908. Hongkong. 1909. 12, (108) p. f°.

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Verzeichnis der Bibliothek des Zentralbureaus der Internationalen seismologischen Assoziation. Strassburg. 1909. Würzburg. 1909. 22 p. 8°.

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Traité de géographie physique. Climat.—Hydrographie.—Relief du sol.—Biogéographie. Paris. n. d. 204 p. 8°.

Montevideo. Observatorio del Prado.
Anuario del Instituto nacional físico-climatológico (Observatorio del Prado). Año 7 (1907). Montevideo. 1908. 16 p. f°.

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Verhandlungen. 46 Bd. 1907. Brünn. 1908. xx, 137 p. 8°.

Norway. Norske meteorologiske institut.
Jahrbuch ... 1908. Kristiania. 1909. 122 p. f°.
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Annual report ... 1907. p. 1. Manila. 1909. 153 p. 4°.

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Solflekkernes variationer og de i sammenhaeng dermed staende periodiske forandringer av klima og jordmagnetisme. Christiania. 1909. 21 p. 8°. (Christiania Videnskabeselskabs forhandlinger for 1908. no. 3.)

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... Die Luft. Leipzig. 1886. vi, 242 p. 8°. (Handbuch der Hygiene und der Gewerbekrankheiten. 1. Theil. 2. Abth. 3. Heft.)

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... Otchet [Report]. 1905. St. Petersbourg. 1907. 135 p. f°. (Mém. Acad. imp. sc. St. Pétersb. 8 sér. v. 23. no. 1.)

Russia. [Hydrographic office.]
Sbornik gidro-meteorologicheskikh nabliudenii ... Vypusk 3, 1899. Sanktpeterburg. 1902. 4°.

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Der Einfluss des Mondes auf unsere Atmosphäre ... Karlsruhe. 1908. 31 p. 4°.

Smits, A.
... De zodiakaallicht-theorie van Schmidt. (Overgedrukt uit het "Marineblad," 3 Aflev., Jaarg. 1909-1910. p. 200-218.)

Stephan, Georg.
Ueber den Einfluss der orographischen Lage auf die interdiurne Temperaturveränderlichkeit im Thüringer Wald. Inaug.-diss. Jena. 1908. 54 p. 8°.

Stephenson, James.
... Irrigation in Idaho. Washington. 1909. 59 p. 8°.

Sutton, J. R.
Earth temperatures at Kimberley. (From the Transactions of the South African philosophical society. v. 18, pt. 4. Mch., 1909. p. 421-435.)

Tananarive. Observatoire de Madagascar.
... Observations météorologiques faites à Tananarive. v. 6, 7, 11-15; 1894, 1895, 1899-1903. Toulouse. 1909. 7 v. 8°.

U. S. Coast & geodetic survey.
... Results of magnetic observations made by the Coast and geodetic survey between July 1, 1907, and June 30, 1908. Washington. 1909. p. 71-165. 4°. (Appendix no. 3, Report for 1908.)

Venice. Ufficio idrografico.
... Bollettino ... Dati orari osservati a Venezia 1908. 1908.
... Bollettino ... Dati osservati nelle stazioni meteorologiche ... Venezia. 1908.

Württemberg. Kgl. Württembergisches meteorologisches Zentralstation.
Deutsches meteorologisches Jahrbuch 1908. Stuttgart. 1909. 55 p. f°.

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Bulletin des observations. Tome 32. Année 1906. Fasc. A. Magnétisme terrestre. Chang-hai. 1909. A1v, A61 p. f°.

AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

By Mrs. Grace J. Livingston. Dated Washington, D. C., January 8, 1908.

[*Continued from the Monthly Weather Review, May, 1909.*]

1906—*Continued.*

Hilgard, E. W.
Soils, their formation, properties, composition, and relations to climate and plant growth in the humid and arid regions. New York. 1906. xvii, 593 p.

On p. 192-4, 253-66, and 455 discusses the relation of evaporation to agriculture. On p. 253 the section "Evaporation" includes a general discussion of evaporation from soil and water surfaces. Fortier's (1905) experiments showing the influence of temperature on evaporation from water, are described, and a table of evaporation in different climates is presented.

Keeling, B. F. E.
Note on evaporometers. Mo. weather rev., 1906, **34**:157.

An account of the results of comparisons of the indications of various evaporometers as made at Helwan Observatory, Helwan, Egypt. The results are given in tabular form, and show that the mean ratio of the Piche to the Wild evaporometer readings is 1.44, that of the Wade to the Wild is 1.37, and that of the Wade to the Piche is 0.96. The ratio Piche to Wild, 1.44, is about 10 per cent greater than that found by T Russell, but this difference is probably to be explained by the difference in the dimensions of the instruments. Describes the Wade evaporometer designed by E. B. H. Wade, of the Survey Department of Egypt.

Keller, H.
Niederschlag, Abfluss und Verdunstung in Mitteleuropa. Zentralblatt der Bauverwaltung, Berlin, 1906, **26**:279. Also Jahrb. Gewässerk., Besond. Mitt., Berlin, I, 1906, 4, p. 43.

The main results may be tabulated as follows:

Region.	Rainfall.	Run-off.	Evaporation.
	Mm.	Mm.	Mm.
North-central Europe	610	150	460
Danube-Rhone region	962	502	460
Central Europe in general	714	268	446

Ladd, E. F.
Summaries of temperatures, rainfall, sunshine, and evaporation. North Dakota exp. sta. rpt. for 1905,(—):16–19. Summary in Exp. sta. rec., 1906, **18**:10.

The mean temperature for 1905 was 39.43° F., the total rainfall was 30.76 inches, the evaporation for the five months, May to September, was 26.45 inches. A comparison between the rainfall and evaporation for the corresponding periods of the years 1902–1905 shows usually an excess of evaporation, 1.96, 2.56, and 2.74 being the ratios, although in 1905 they were practically equal.

Leake, H. M.
Some preliminary notes on the physical properties of the soils of the Ganges Valley, more especially in their relation to soil moisture. Jour. agr. sci., 1906, **1**:454–69. Abstract in Exp. sta. rec., 1906, **18**:13.

The determinations of percentage of soil samples indicate a loss by evaporation equivalent to 210 tons of water per acre from October 10 to November 21, or an average daily loss of 4 tons per acre. This is thought to be much higher than the actual.

Livingston, Burton E.
The relation of desert plants to soil moisture and to evaporation. Carnegie Inst. Washington, Pub. 50. Washington, 1906. 78 p.

Studies of evaporation rates from soil and water were made at Tucson, Arizona, in the summer of 1904. It is shown that the relatively high moisture content in the deeper layers of clay soils in this region is due, in part, to the fact that the evaporating power of the air is so excessively high that the movement of the soil water can not keep the upper layers moist, and a dry mulch forms which tends to prevent further evaporation. Describes a porous clay evaporometer essentially the same as those employed by Babinet (1848), Marié-Davy (1869), and Mitscherlich (1904). It is pointed out that the evaporating power of the air can not be shown by the psychrometer, as this leaves out of account the factor of air currents. Next to an evaporometer the stationary wet- and dry-bulb thermometers, placed in the open air, are considered the most reliable instruments for estimating evaporation. The ratios between the reading of the evaporometer and transpiration from plants indicate a physiological regulation of evaporation within the plant. Comparative experiments were made with an air current at various velocities produced by an electric fan; a velocity of 4.6 meters per second increased evaporation 250 per cent, and a velocity of 8.0 meters per second increased it 450 per cent.

Luedecke, Carl.
Das Verhältniss zwischen der Menge des Niederschlages und des Sickerwassers. Mitt. Landw. Inst., Breslau, 1906, **3**:615–46.

Manila Central Observatory.
Meteorological data reduced from hourly observations. Phillipine Weather Bureau Bulletins, January to July, 1906. Manila, P. I.

The record of evaporation at Manila may be tabulated as follows:

Month.	Evaporation.		Rainfall.
	In sun.	In shade.	
1906.	Mm.	Mm.	Mm.
January	192.2	91.1	12.7
February	219.7	104.5	13.4
March	....	....	....
April	313.5	153.0	4.9
May	246.2	125.9	358.4
June	158.9	84.5	154.9
July	177.1	94.5	310.2

Mill, Hugh Robert.
Records of evaporation and percolation. Brit. rain., 1906, **46**:46–52. Rev. in Nature, 1907, **76**:587. Abst. Exp. sta. rec., 1907, **19**:711–2.

The evaporation at 11 stations averaged 18.07 inches with a rainfall of 30.15 inches. This article is accompanied by a plate showing comparative curves of evaporation and other meteorological data, as in 1905. A table prepared by David Ronald compares evaporation from sandy soil, as calculated from rainfall and percolation, with evaporation from free water surface at Cauldhame, Falkirk. The rainfall was 39.93 inches, the evaporation from sand 19.83 inches, and evaporation from free water surface, 13.51 inches. According to Latham's experiments in 1806 chalk allows less percolation and consequently greater evaporation than gravel.

Miller, N. H. J.
The amount and composition of the drainage through unmanured and uncropped land, Barnfield, Rothamsted. Jour. agr. sci., 1906, **1**:377–99.

With the aid of gages he estimates the annual evaporation from undisturbed soil during the period 1870–1905, grouping it under various amounts of rainfall.

Mitchell, F. C.
The evaporation of ice. Mo. weather rev., 1906, **34**:526–8.

Careful determinations of the loss of weight of ice, due to evaporation for short periods and at temperatures below 0°C., showed that the rate of evaporation increases with the temperature and atmospheric pressure. It is further shown that the rate is proportional to the area exposed.

Neruchev, M.
Precipitations, their income and outgo in relation to droughts. Zap. Imp. Obsch. Selsk. Khoz. Yuzh. Ross., 1906, No. 4–6. Abstract in Zhur. opuitn. agron., (Russ. Jour. exp. Landw.), 1907, **8**:119–120; Exp. sta. rec., 1907, **19**:414.

The droughts in southern Russia are attributed not to deficient rainfall, but to the high evaporation which considerably exceeds the rainfall.

Newton William B.
The aquameter. Quart. jour. roy. met. soc., 1906, **32**:11–13. Notice in Science, 1906, **23**(N. S.):853.

A résumé of the principles of hygrometry and the use of wet- and dry-bulb thermometers. The "aquameter" is designed to show the amount of water vapor contained in a certain amount of air by measuring, by means of a mercury column, the change in pressure produced by absorbing the water vapor with phosphoric anhydride.

Praagh, L. V.
Meteorology of the Transvaal. From "The Transvaal and its Mines." London and Johannesburg. 1906. p. 90–3. Abstract in Exp. sta. rec., 1907, **19**:711.

Evaporation in the Transvaal is approximately three times the rainfall. The mean annual rainfall for 14 years at Pretoria was 26.31 inches.

Réthly, A.
Die Verdampfungsverhältnisse von Siófok. (Magyar.) Időj. Budapest, 1906, **10**:76–8.

Savinov, S. I.
Verdunstung im Schatten. (Russian.) Met. vēst., 1906, **16**:349–54.

Schwab, Franz.
Ueber die Verdunstungsmessungen in Kremsmünster. Met. Zeits., 1906, **Hann Band**:23–35.

Discusses the various methods of observing evaporation practiced at Kremsmünster from 1824 to the present time. Annual rates varying according to the exposure and instruments, from 1358.9 mm. to 228.9 mm. are recorded. Rates from other places are quoted. The daily curve of evaporation was studied with the Wild atmometer from June, 1904, to September, 1905. The ratio between the nocturnal and diurnal amounts is shown to vary, with the temperature, from 2.8 mm. in June to 1.5 mm. in November. The daily maximum always occurred between 2 and 4 p. m., coincident with the temperature maximum and the relative humidity minimum.

Seelhorst, C. von.
Feuchtigkeitsverhältnisse eines Lehmbodens. Jour. Landw., 1906, **54**:187–206.

Determinations of the moisture content of the soil showed that rye used much less soil water than wheat, oats demanded a large amount of water and clover the most. Peas used a relatively small amount and potatoes the least.

Seelhorst, C. von.
Wasserverdunstung und Wasserabfluss eines gebrauchten Lehm- und Sandbodens. Jour. Landw., 1906, **54**:313–5. Abstract in Exp. sta. rec., 1907, **18**:617.

Observations of drainage and evaporation from loam and sandy soils, in large vegetation tanks, from October, 1904 to March, 1906, show that evaporation was largest and drainage smallest from the loam during the fall and winter, the same being true of the sandy soils in summer. The evaporation was as a rule smaller, and the drainage larger, from the sandy soil than from the loam. Greater evaporation from the sandy soil was observed only during a period of high temperature and heavy rainfall in summer. The greater evaporation from the loam soil is attributed to slower percolation and greater capillary capacity in this soil.

Seelhorst, C. von.
Ueber den Wasserverbrauch von Roggen, Gerste, Weizen und Kartoffeln. Jour. Landw., 1906, **54**:316–42.

Careful experiments at Göttingen in 1905 on the amount of moisture used and evaporated by rye, oats, wheat, and potatoes in loamy and sandy soils.

Strachan, Richard.
Methods of estimating evaporation. Horological Journal, 1906, **48**:79–80, 95–6, 160–2, 178–80.

Compares and discusses formulas for calculating evaporation, including Mann's (1871), Fitzgerald's (1886), Wellenmann's (1877), Stelling's (1881), and Strachan's (1905).

Vernon, J. J.
Irrigation. New Mexico Exp. sta. rpt., 1906. p. 29–38. Abstract in Exp. sta. rec., 1907, **19**:384.

Evaporation for a year at the New Mexico experiment station amounted to 58 inches.

Victoria, Ernesto G.
Evaporación y frio producido por ella en Lima. Bol. soc. geog. Lima, 1906, **19**:1–58.

The construction, exposure, and method of observing the Piche evaporometer are described, together with an account of the causes which favored or retarded evaporation. The daily maximum evaporation in the sun and shade, from 1897–1905, fell usually in February or March, and the minimum in July or August. A study of the depression of the wet-bulb thermometer both in the sun and shade, shows an increase in arithmetical progression, from autumn to summer, the amount varying during the year from 0° to 10°C. Concludes that this cooling varies inversely with barometric pressure, relative humidity, and rainfall, but directly with temperature, the hours of sunshine, and the direction of the wind. Tables of all observations are presented.

1907.

Abbot, H. L.
Rainfall and outflow above Bohio, in the valley of the Chagres. Mo. weather rev., 1907, **35**:74–5. Review in Met. Zeits., 1908, **25**: 326–30.

From the difference between the rainfall and the total river flow, the average annual evaporation on the Isthmus of Panama (1898–1906), is estimated as 38.29 inches. Direct measurements by the pan method show 0.135 inches per twenty-four hours in December, 1906, 0.167 inches for January, 1907, and 0.181 inches for February, 1907. The first method gives negative evaporation for these months.

Abe, K.
On the density of snow on the ground and the evaporation from its surface. (Japanese.) Jour. met. soc. Japan, April, 1907, **26**.

Badgley, W. F.
Evaporation from the soil. Quart. jour. roy. met. soc., 1907, **33**:182.

An unsatisfactory attempt to measure the evaporation from soil by collecting on a cold surface and weighing the vapor rising from a certain area.

Barbour, Percy E.
The Salton sea. Journal of Worcester Polytechnic Institute, 1907, **10**:165–71.

An estimate of the annual evaporation from the Salton Sea based on estimates of the time and quantities of water required to fill the Salton Sink to various levels.

Bigelow, Frank H[agar].
Studies on the phenomena of the evaporation of water over lakes and reservoirs. (I) The proposed study on the problems of evaporation at the Salton Sea, California. Mo. weather rev., 1907, **35**: 311–6. Reprinted, Washington, D. C., 1907.

An account of proposed cooperative study of evaporation on a large scale at the Salton Sea by the U. S. Geological Survey, the U. S. Reclamation Service, and the U. S. Weather Bureau. Describes the conditions to be expected in the arid regions of the West, the past history and future possibilities of Salton Sea, the need for investigation of evaporation, and the present favorable opportunity for studying the phenomenon as it is occurring naturally from this large isolated water surface. The need for further research into the theory of evaporation is shown by a comparison of formulas previously developed. The formulas quoted, with the exception of Russell's, are transcribed into a uniform notation, and he endeavors to show their lack of agreement. Discusses Stefan's thermodynamic theory of evaporation, and presents the general theory of evaporation.

Boulatovitch, M. and A. Winkler.
Meteorological observations at the Ploti Experiment Station, 1907. Godichnuii Otchet Ploty. Selsk. Khoz. Opuitn. Stantzii, 1907, **13**: 1–53, 161–7. Exp. sta. rec., 1909, **20**:616.

The total evaporation for 1907 was 23.3 inches, the average annual for 13 years was 32.5 inches. The rainfall for 1907 was 11.37 inches, the average annual for 13 years being 16.26 inches. The mean relative humidity for 1907 was 70 per cent, and the average temperature 7.8°C.

Buckingham, E. and F. K. Cameron.
Studies on the movement of soil moisture. U. S. Bur. Soils, Bul. 38. Abstract in Exp. sta. rec., 1907, **18**:820.

Evaporation from points below the surface of soils in tumblers or small cylinders, under various conditions, while measureable is quite small and negligible in comparison with the losses taking place at or very near the surface. A comparison of loss of water from a soil under arid and humid conditions shows it to be much more rapid at first under the arid conditions, so rapid "as to overtax the soil's ability to move water from within to the surface by capillarity." A dry layer is therefore formed which keeps the losses far below those from the soil under humid conditions where the capillary flow to the surface persists until the moisture content of the whole soil is very low.

Cameron, F. K.
See Buckingham, E. and F. K. Cameron.

Fritzsche, R.
Niederschlag, Abfluss und Verdunstung auf den Landflächen der Erde. Zeits. Gewässerk., 1907, **8**:74.

Gravelius, Harry.
Untersuchungen zur Abflussfrage. Zeits. Gewässerk., 1906, **8**:15–37.

Hoyt, John Clayton and Nathan Clifford Grover.
River discharge. New York. 1907.

The authors declare that the difference between the annual rainfall and run-off represents very closely the annual evaporation. Evaporation influences both the total and the seasonal flow of streams. The annual evaporation from water surfaces is estimated as varying from 20–40 inches in the humid Eastern States to 70–100 inches in the arid West. Discusses briefly the effect of the character of the soil and vegetation on evaporation.

Keeling, B. F. E.
The climate of Abbassia near Cairo. Cairo. 1907. Review in Met. Zeits., 1908, **25**: 458–60.

Evaporation was measured at the observatory at Abbassia by means of a Wild evaporometer placed in the thermometer shelter. The average monthly amounts for the years 1900–1903 varied from 45 millimeters in January to 214 millimeters in June; the annual average was 1577 millimeters.

Knoche, Walter.
Die Verdunstungs- und Kondensation-Grenze an der Wolkenoberfläche. Met. Zeits., 1907, **24**: 369–71.

A mathematical discussion of the relations between condensation on and evaporation from the surface of clouds.

Ladd, E. F.
Evaporation from water surfaces. North Dakota Exp. sta. rpt., 1907, pt. 1, p. 33–6. Exp. sta. rec. 1909, **20**: 515.

This report contains, according to the Experiment station record, "a record of observations on evaporation from the surface of water contained in a galvanized iron tank, the evaporation during 1907 being compared with that of five previous years and with the rainfall during the same period."

Livingston, Burton E.
Evaporation and plant development. Plant world, 1907, **10**: 269–76. Abstract, Exp. sta. rec., 1908, **19**: 1024–5.

Describes a simplification of his evaporometer (see 1906) for general ecological and physiological work. Discusses an experiment which shows that the evaporating power of the air may be so high that the rate of transpiration exceeds the rate of moisture supply, even though the soil be kept well watered.

Luedecke, Carl.
Das Verhältniss zwischen der Menge des Niederschlages und des Sickerwassers nach Englischen Versuchen. Kulturtechniker, 1907, **9**: 101–26.

Merz, Alfred.
Beiträge zur Klimatologie und Hydrographie Mittelamerikas. Mitt. Verein Erdk., Leipzig, 1906, (—):——. Reprinted Leipsic, 1907. 96 p. 3 Pl. Review in Met. Zeits., 1908, **25**: 326–30.

An elaborate discussion of the rainfall and run-off in various regions of Central America. Evaporation is considered equal to the rainfall minus the run-off. The annual amount of evaporation from Managua Lake is reported as 1,575 millimeters, with a rainfall of 1,185 millimeters, and from Nicaragua Lake the figures are respectively 1,309 and 1,599 millimeters. In the flood region of the San Juan the rainfall varies from 1,709 to 3,263 millimeters, with corresponding evaporation rates of 1,177 and 1,110 millimeters. The reviewer considers that the observations on these lakes probably give greater amounts than the reality, and finds it interesting to compare these numbers with the fantastic amounts, up to 7 meters a year, which were formerly assumed for tropical oceans.

Merriman, Thaddeus.
Rainfall and run-off of the Catskill mountain region. Mo. weather rev., 1907, **35**: 109–18.

Enumerates and discusses (p. 114–5) the general laws of evaporation over large districts, and calculates the percentage of rainfall evaporated over the Croton, Pequanac, and Sudbury watersheds under various temperatures.

Mill, Hugh Robert.
Records of evaporation and percolation. Brit. rainf., 1907, **47**:44–51.

The usual data are given. The accompanying plate presents comparative curves of evaporation and other meteorological data, as in 1905 and 1906, including the record of a new instrument, the Wilson radio-integrator. The curve made by this instrument closely resembles that of evaporation from an exposed water surface during August and September, but during November and December it is quite characterless. The evaporation curve follows those of duration of sunshine and black-bulb temperature in summer, and those of mean temperature of water and soil at 1 foot depth in winter. The curve of wind velocity here seems to have very little relation to that of evaporation. Latham's tables, Hall's at Rothamsted and Ronald's at Cauldhame, Falkirk, are included.

Rykachev, M.
(New evaporometer for observing evaporation from grass, and the first observations with this instrument at the Constantine Observatory in 1896.) Mém. acad. imp. sci., St. Petersburg, phys.-math. Cl., **7** (sér. 7), No. 3.

Stevens, J. S.
Meteorological conditions at Orono, Maine. Univ. Maine Studies, No. 7. 52 p. Chart 1. Abstract Exp. sta. rec., 1907, **19**: 311.

Includes results of a series of special observations on the evaporation of snow, ice, and liquids.

Summers, W. L.
Semi-arid America, its climate compared with that of South Australia. Jour. dept. agr., So. Aust., 1907, **10**: 411–4. Abstract in Exp. sta. rec., 1907, **18**: 1022–3.

The evaporation in the semi-arid regions of America is said to be less than in those of South Australia.

Sutton, J. R.
A contribution to the study of evaporation from water surfaces. Sci. proc. roy. Dublin soc., 1907, **11** (N. S.): 137–78. Abstract in Exp. sta. rec., 1907, **19** :617–8.

The amount evaporated at Kimberley from a Piche evaporometer was 84.48 inches, and from a screened metal vessel, 14 inches in diameter and 18 inches deep, 65.94 inches.

Tinsley, J. D.
Forty years of southern New Mexico climate. New Mex. exp. sta. bul., No. 59. Abstract in Exp. sta. rec., 1907, **18**: 611. Review in Bul. Am. geog. soc., 1907, **39**: 419.

The evaporation in this region is given as 5 to 6 feet per year.

Todd, Sir Charles.
Meteorological observations made at the Adelaide Observatory and other places in South Australia and the Northern Territory during the year 1905. Adelaide. 1907. Review in Met. Zeits., 1908, **25**: 478–9.

The results obtained by Sir Charles Todd show a monthly average evaporation, for the years 1870–1904, varying from 32 millimeters in June to 225 millimeters in January; the average annual evaporation is 1,396 millimeters.

Wilcox, Lucius N.
Irrigation Farming. New York. 1907.

On pp. 149 and 464, the relation of evaporation to agriculture, especially in the arid regions, is treated, with estimates of amounts evaporated daily from canals and reservoirs.

Winkler, A.
See Boulatovitch, A. and A. Winkler.

Bigelow, Frank H[agar].
Studies on the rate of evaporation at Reno, Nev., and in the Salton Sink. Nat. geog. mag., 1908, **19**: 20–8.

The author describes the Salton Sea and its origin. It has been generally supposed that the depth of the annual evaporation from the surface of this sea is as much as 8 feet, but the author believes, on the basis of experiments made at Reno, Nev. (cf. next entry), that it may not be more than 4 or 5 feet.

Bigelow, F[rank] H[agar].
Studies on the phenomena of the evaporation of water over lakes and reservoirs. II. The observations on evaporation made at the reservoir in Reno, Nev., August 1 to September 15, 1907. III. Discussion of the observations made at Reno, Nev., August 1 to September 15, 1907. Mo. weather rev., 1908, **36** :24–39, Charts 17–27. Reprinted, Washington, D. C., 1908.

The author describes the Reno, Nev., reservoir, the general conditions of the experiments, and the methods of observing. He calculates tables of vapor pressure and evaporation at Reno, Nev., August 1–10, 12–17, 1907. Five towers were erected for the purpose of studying evaporation and the phenomena most closely related to it. These towers were located on an east and west line crossing both basins of the reservoir, and exposed to conditions ranging from arid, over an unirrigated field, to humid over an irrigated alfalfa field. Twenty-nine galvanized-iron pans were employed. Three 6-foot pans were floated in water at the foot of towers 2, 3, and 4, two others were on the ground at the foot of towers 1 and 5. Pans 2 feet in diameter were placed on the towers at levels of 0, 2, 7, 15, 25, 35, and 45 feet. Sling and floating psychrometers [see Marvin, 1909, 3d title] were used to find the temperatures and vapor pressures in and near the pans. The level of the water was read by means of a vertical scale tube. Readings were taken of all the instruments every three hours from 5 a. m. to 8 p. m., and also at 1 a. m. The author concludes that "the location of the pans relative to the water of a reservoir is of primary importance in measuring the total amount of evaporation and that observations on a pam away from the water can not be transferred to the water surface itself, except with the utmost caution."

The observations show the existence of a vapor blanket extending some 30 feet above the surface of the reservoir, and a similar, but less perfect blanket, over the alfalfa field.

The author develops the following formula:

$$E = Cf(h)\, e \frac{de}{ds} (1 + Aw),$$

where E = evaporation, h = height above water surface, e = vapor pressure at the dew-point, de/ds = rate of increase of vapor pressure with rise of temperature, A = a constant modifying the wind, w = wind velocity in kilometers per hour, and $Cf(h)$ = a complex variable depending on h. In a summary the author describes a modified form of the Piche atmometer, which it had been hoped could ultimately be substituted for the large pans. A general conclusion is that the vapor blanket above the reservoir seems to conserve about ½ of the water that would otherwise be lost by evaporation.

Boname, P.

Meteorology. Sta. agron. Mauritius, Bul., **16**:1–15. Abstract Exp. sta. rec., 1908, **20**:212.

Presents records of evaporation in Mauritius during 1906 and 1907.

Brückner, Eduard.

Niederschlag, Abfluss, und Verdunstung auf den Landflächen der Erde. Met. Zeits., 1908, **25**:32–5. Abstract Exp. sta. rec., 1908, **20**:114.

The author compares estimates made by various writers, of total rainfall, runoff, and evaporation on the land surfaces of the earth. Points out that over the water surface of the earth evaporation exceeds precipitation, but that 92 per cent of the moisture evaporated falls again upon the water surface of the globe. Over the lands evaporation is decidedly less than precipitation, about 2 : 3. About 70 per cent of the precipitation on the land surface is derived from evaporation from the land.

Day, F. H.

Deficient humidity. Mo. weather rev., 1908, **36**:404–6.

In course of studies on the physiological effects of indoor aridity the author carried out several comparisons between the indications of various instruments for determining dew-point and vapor pressure, viz, chemical analysis, stationary wick-psychrometer, Regnault hygrometer, and the whirled psychrometer. He finds a close agreement between the results by the chemical method and the whirled psychrometer, and Regnault's dew-point apparatus.

Etna Observatory.

Meteorologische Beobachtungen zu Catania, 1892 bis 1905. Met. Zeits., 1908, **25**:137–8.

Observations by A. Ricco and Cavasion, at the base station of the Etna Observatory show a monthly evaporation varying from 1.80 centimeters in January to 5.55 centimeters in July, with an average monthly total of 3.27 centimeters.

Gager, C. Stuart.

The evaporating power of the air at the New York Botanical Garden. Mo. weather rev., 1908, **36**:63–4. Abstract Exp. sta. rec., 1908, **19**:1010–11.

Experiments to determine the evaporating power of the air were carried on at the New York Botanical Garden from June 10 to October 14, 1907. Employed three different Livingston evaporometers which gave results varying from 4.84 to 12.10 inches according to exposure. The rainfall for the period was 9.32 inches. The difference between rainfall and evaporation is regarded as an index of the evaporating power of the air for the given station.

Hall, A. D.

The Soil. An introduction to the scientific study of the growth of crops. New York. 1908.

In a chapter on tillage and the movements of soil water the author points out the effect of cultivation in checking evaporation from the soil.

Livingston, B[urton] E.

A sample atmometer. Science, 1908, **28**(N. S.):319–20.

Illustrates a modification of the evaporometer described in 1906. The indications of any one instrument must be corrected by a coefficient obtained by comparing it with a standard instrument. Recommends this instrument for studies dealing with the relations between meteorological conditions and plant growth.

Livingston, Burton E.

Evaporation and plant habitats. Plant World, 1908, **11**:1–9. Review, Exp. sta. rec., 1908, **19**:1025.

A study of the evaporating power of the air in several plant habitats at St. Louis and Columbia, Mo., leads to the conclusion that the marked differences in the weekly rates, as indicated by Livingston evaporometers, may furnish a measure of the conditions controlling the character of the vegetation. The weekly rates of several evaporometers exposed at altitudes between 2,412 and 8,000 feet in the neighborhood of Tucson, Ariz., showed a decrease from 298 to 133 cubic centimeters.

Livingston, Burton E.

Evaporation and centers of plant distribution. Plant World, 1908, **11**:106–12.

The author discusses the relation between the evaporating power of air to the geographic distribution of vegetation in the United States. "To test the value of evaporation alone as a criterion for relating plant distribution to climatology" porous cup evaporometers of the pattern described above [first paper], were exposed at a number of places in the United States. The resulting weekly rates, for seventeen weeks, June 3 to September 30, 1907, are to be considered "only as relative measures of the evaporating power of the air." Grouping the results according to the plant centers represented, when the evaporation for the conifer region is taken as unity, the deciduous forest center becomes 1.15 and the deserts of the southwest, 2.86. These number are found to form a series similar to that obtained by Transeau (1905). The author concludes that the evaporating power of the air offers a promising criterion for relating vegetational centers to climatic factors.

Norton, J. H.

Quantity and composition of drainage water and a comparison of temperature, evaporation, and rainfall. Jour. Amer. chem. soc., 1908, **30**:1186–90. Abstract, Exp. sta. rec., 1909, **20**:814–15.

Studies in the drainage basin of Richland Creek, Madison and Washington counties, Ark., showed that during the growing season evaporation was more than 90 per cent of the rainfall, and the ratio for the whole year 70 per cent.

Schubert, [Johannes].

Der Wasserhaushalt an der Erdoberfläche. Met. Zeits., 1908, **25**:415–6.

In a paper before the Dresden Geographical Society on the relations between rainfall and evaporation, Schubert states that a long English record of the percolation through soil shows the evaporation is about one-half the rainfall. Brückner and Fritsche are cited as authorities for the statement that the total annual evaporation from the land surfaces of the globe averages 61 centimeters and the rainfall 87 centimeters. For the districts with no run-off the two phenomena are considered to balance each other at 33 centimeters. Keller's still closer estimate for middle Europe gives average evaporation for the years 1851–1890, 44.6 centimeters with a rainfall of 26.8 centimeters.

Sprung, A.

Die registrierende Laufgewichtswage im Dienste der Schnee-, Regen- und Verdunstungsmessung. Met. Zeits., 1908, **25**:145–54.

Describes a self-registering sliding weight balance for measuring snow, rain, and evaporation, and presents tables and register curves.

Transeau, Edgar N.

The relation of plant societies to evaporation. Bot. gaz., 1908, **45**:217–31. Abstract, Exp. sta. rec., 1908, **20**:224.

From his efforts to obtain quantitative measurements of the various environmental factors influencing plant societies, the author concludes that comparative evaporation data "would be far more valuable than the usual temperature and relative humidity readings." The instrument used for measuring this factor was the porous cup atmometer described by Livingston (1908). The standard instrument placed in the garden of the Station for Experimental Evolution, Long Island, N. Y., evaporated 1,657 centimeters during twelve weeks, May 20 to August 11, inclusive. Other instruments evaporated, according to environment, from 10 per cent to over 120 per cent of the amount given off by the standard instrument. The author considers that the use of this instrument will be of the greatest importance in the study of habitat conditions, since its surface is constant and continually exposed in the same way, thus furnishing data which may be directly related to the plant.

Voeikov, Alexander.

The study of evaporation. Mo. weather rev., 1908, **36**:63.

The author suggests that the discrepancies between the various formulas for evaporation which were pointed out by Bigelow (1907) may be due to the fact that the anemometers are usually placed higher than the evaporometers. Local conditions of exposure may so disturb the relations that coefficients deduced from one set of observations will give smaller values than another set for the same wind velocity. A table of results obtained at Pinsk and Vasilivichi (June to September, 1897) is given as a case in point. The monthly amount at the former place varied from 34.5 millimeters in September to 71.4 millimeters in June, and at the latter place from 52.9 millimeters in September to 96.6 millimeters in June.

Ward, Robert DeCourcy.

The relative humidity of our houses in winter. Boston surg. and med. jour., 1900, March 1. Reprinted in Jour. sch. geog., 1902, **1**:310–17. Abstract Mo. weather rev., 1908, **36**:281–3.

This is a series of comparative observations on the relative humidity within and without a hot-air heated house in Cambridge, Mass. The author shows that the air within such a house in winter is usually as arid as the air of the deserts of the globe, and sometimes even exceeds this. He comments on the physiological effects of the sudden transition from the arid indoors to the usual winter outdoors. Doctor Barnes' table of similar observations in the hospitals of Boston is added.

1909.

[Abbe, Cleveland].

The psychrometer: Rotated, whirled, ventilated. Mo. weather rev., 1909, **37**:23.

Emphasizes the necessity for accurate instrumental determinations of the relative humidity in biological investigations. Compares the relative accuracy of results obtained by means of the O'Gara (1909) rotation psychrometer, the sling psychrometer, and the Assmann aspiration psychrometer. A high grade of thermometer is necessary in psychrometric work, and the reduction tables must be adapted to the style of thermometers used.

Jefferson, M[ark] S. W.

Winter aridity indoors. Jour. sch. geog., 1902, **1**:.. Reprinted, Mo. weather rev., 1909, **37**:62–3.

The author, stimulated by Ward's paper (see 1908), calculates the actual volume of water which should be evaporated by a heating and ventilating plant and added to the warm air in order to preserve a healthful indoors humidity during the winter. He finds that each individual may require from 3.7 quarts up to as much as 13.7 quarts daily to properly moisten air derived from outdoors and raised to 70° F. by the heating plant of the house. A schoolhouse would need 200 gallons daily for each 100 pupils sheltered, under the average conditions described by Ward (1908).

Marvin, Charles Frederick.

The pressure of saturated vapor from water and ice as measured by different authorities. Mo. weather rev., January, 1909, **37**:3–9, chart **37**–11, XI.

This paper reviews and compares vapor pressure measurements, formulas, tables, etc., by Regnault, Broch, Juhlin, Marvin, Thiessen and Scheel, Ramsey and Young, Battelli, Cailletet and Colardeau, Holborn-Henning, Ekholm, Landolt and Börnstein, Wiebe and others. It also gives a short bibliography.

Marvin, Charles Frederick.

A proposed new formula for evaporation. Mo. weather rev., February, 1909, **37**:57–61.

The author points out the fundamental faults in the evaporation formulas commonly employed, and proposes the form of equation

$$dF/dt = C/B.\ (e_s + e_a - 2e_d)\, f(e)\, f(v),$$

where C=constant, B=barometric pressure, e_s, e_a, e_d,=vapor pressures corresponding to water service temperature, air temperature, and dewpoint temperature respectively, $f(e)$= function of the vapor pressure to be evaluated by the observations, as also $f(v)$, depending on the wind effects.

Marvin, Charles Frederick.

Methods and apparatus for the observation and study of evaporation. Mo. weather rev., April, May, 1909, **37**:141–6, 182–91.

Part I discusses methods, formulas, etc. Part II describes and illustrates instruments and apparatus for measuring and automatically recording evaporation chiefly from pans.

O'Gara, P[atrick] J.

A portable rotation psychrometer. Mo. weather rev., 1909, **37**:22–3.

Describes a form of whirled psychrometer improvised by attaching two spherical-bulbed thermometers to opposite sides of one dasher of the ordinary egg beater, and removing the other dasher. The gears give a linear velocity of 25 feet per second and the steel dasher serves as an admirable protection for the thermometers, while the whole apparatus can be safely and accurately placed where the observations are particularly desired.

ADDENDA.

1787.

Saint-Lazare, Bertholon de.
De l'électricité des météores. Paris. 1787. 2 vol. 8vo.

In vol. 2, p. 84-99, he discusses evaporation.

1891.

Marvin, Charles Frederick.
Report of vapor pressure measurements and normal barometer construction. Pt. I.—Maximum pressures of aqueous vapor at low temperatures. Ann. Rpt. Chief Signal Officer for 1891, (App. 10). Washington. 1892. 8vo. p. 351-383.

Special precautions were observed in this work to eliminate errors due to the use of impure water, the presence of air in the space occupied by the vapor, and on account of unequal capillary action. Water previously freed from air by boiling was finally distilled in a vacuum at a temperature but slightly above freezing. The pressure was measured in highly exhausted U-tube mercury manometers 25 to 30 millimeters in diameter. The results brought out the distinct difference between vapor pressures over ice and over water subcooled as much as 20 Fahrenheit degrees below freezing, but yet retaining its liquid state. The observations were carried to −60° F., and a limited number of measurements were made between 32° and 80° F.

Juhlin, Julius.
Bestimning af Vattenångans Maximi-spänstighet öfver is mellan 0° och −50° C., samt öfver flytande Vatten mellan +20° och −13° C. Bihang till K. Svenska Vet.-Akad. Handlingar. Band 17, Afd. I, No. 1. Stockholm. 1891. Abstract Met. Zeits., 1894, **11**: 98-9.

This investigation into the vapor pressures of water vapor over ice between 0° and −50° C., and over water between +20° and −13° C., gave Juhlin results closely concordant with those obtained simultaneously by Marvin, 1891. Juhlin and Marvin worked simultaneously and by very similar methods, but independently and in ignorance of each other. Juhlin presented his results to the Royal Swedish Academy of Sciences on February 11, 1891, and Marvin reported his to the Chief Signal Officer, U. S. A., on June 30, 1891. (See Marvin, 1909, first title.)

LIST OF ABBREVIATIONS FOR TITLES OF PERIODICALS.

Abh. k. bayer. Akad. Wiss., math.-phys. Kl.	Königlich-bayerische Akademie der Wissenschaften, Mathematisch-physikalische Klasse. Abhandlungen. Munich.
Ann. met. ital.	Annali della meteorologia Italiana. Modena.
Ann. obs. Montsouris.	Annales de l'observatoire météorologique municipale de Montsouris. Paris.
Ann. soc. met. ital.	Annuario della società meteorologiche italiana. Turin.
Atti. r. ist. sci., Naples,	Atti della reale istituto d'incoraggiamento delle scienze naturali, economiche, e technologiche. Naples.
Beibl. Ann. Phys. und Chemie.	Beiblätter der Annalen der Physik und Chemie. Leipsic.
Beitr. Geophysik. Leipsic.	Beiträge zur Geophysik. Zeitschrift für physikalische Erdkunde. Zugleich Organ der Kaiserlichen Hauptstation für Erdbeben-forschung zu Strassburg i. E. Leipsic.
Ber. Deut. Naturf.	Amtliche Berichte über die Versammlungen Deutcher Naturforscher und Aerzte. Leipsic.
Ber. Phys. Med. Soc.	Verhandlungen der physikalisch-medezinischen Societät zu Erlangen. Continued as Sitzungsbericht.
Bot. gaz.	Botanical Gazette. Chicago.
Bul. Amer. geog. soc.	Bulletin of the American geographical society. New York.
Bul. cent. met. obs. Japan.	Bulletin of the Central meteorological observatory, Tokyo, Japan. Tokyo.
Centbl. Agr. Chem. (Biedermann).	Biedermann's Central-Blatt für Agrikulturchemie und rationellen Landwirtschafts-Betrieb. Leipsic.
Comment. Ateneo, Brescia.	Commentari dell' Ateneo di Brescia. Brescia.
Godĭchnuiĭ Otchet Ploty. Selsk. Khoz. Opuitn. Stantzïĭ.	Godĭchnuiĭ Otchet Plotyanskoĭ Selsko-Khozyaĭstvennoĭ Opuitnoĭ Stantziĭ. (Annual report of the Ploty agricultural experiment station). Odessa.
Jour. met. soc. Japan,	Journal of the meteorological society of Japan. Tokyo.
Jour. Scot. met. soc.	Journal of the Scottish meteorological society. Edinburgh.
Kulturtechniker	Der Kulturtechniker. Breslau.
Landw. Vers. Sta.	Die Landwirtschaftlichen Versuchs-Stationen. Berlin.
Mém. acad. imp. sci., St. Petersburg, phys.-math. cl.,	Mémoires de l'academie imperiale des sciences de St. Petersbourg.
Mem. accad. sci., Bologna.	Accademia delle scienze dell'istituto di Bologna. Memorie. Bologna.
Mém. soc. agric., Bayeux.	Societé d'agriculture, sciences, arts, et belles lettres. Memoires. Bayeux.
Met. council rpt.	Report of the Meteorological Council to the royal society, for the year ending March 31. London.
Min. proc. intercol. met. conf.	Minutes of the proceedings of the intercolonial meteorological conference at Melbourne.
Mitt. Landw. Instit.	Mittheilungen der Landwirtschaftlichen Institut der königlichen Universität Breslau. Berlin.
Mitt. Verein. Erdk., Leipsic.	Mittheilungen des Vereins für Erdkunde zu Leipzig. Leipsic.
Naturw. Runds.	Naturwissenschaftliche Rundschau. Brunswick.
Nebr. exp. sta. bul.	Bulletin of the Nebraska experiment station.
Natkdg. tidjsch. Ned. Ind.	Naturkundig Tijdschrift voor Nederlandsch Indie. Batavia.
Naturforscher, Berlin.	Der Naturforscher. Wochenblatt zur Verbreitung der Fortschritte in der Naturwissenschaften. Berlin.
Petermann's Mittheil.	Petermann's Mittheilungen aus Justus Perthes' Geographischer Anstalt. (Supan). Gotha.
Plant World	The Plant World. Tucson, Ariz., and Washington, D. C.
Rend. accad. sci., fis. math. sez., Naples.	Rendiconti dell' academia delle scienze, fisiche e mathematiche sezione della Società Reale di Napoli. Naples.
Rpt. Australasian assoc. adv. sci.	Reports of the Australasian association for the advancement of science.
Rpt. So. African assoc. adv. sci.	Reports of the South African association for the advancement of science.
Selsk. Khoz. ĭ Lyesov.	Sel'skoe Khozyaĭstvo ĭ Lyesovodstvo (Rural Economy and Forestry). St. Petersburg.
Sta. agron. Mauritius, Bul.	Colony of Mauritius Station agronomique. Bulletin. Mauritius.
Trans. roy. soc. arts, sci, Mauritius.	Société royale des arts et des sciences de l'île Maurice. Transactions. Port Louis, Mauritius.
U. S. Bur. Soils, Bul.	U. S. Department of Agriculture. Bulletins of the Bureau of soils.
Verhdl. Deut. phys. Gesellsch.	Verhandlungen der Deutschen physikalischen Gesellschaft. Berlin.
Versuchsstat. Org.	Die Landwirtschaftlichen Versuchs-Stationen. Berlin.
Zap. Imp. Obshch. Selsk. Khoz. Yuzh. Ross.	Zapiskĭ Imperatorskagho Obshchestva Selskagho Khozyaĭstva Yuzhnoĭ Rossiĭ. (Memoirs of the imperial society of rural economy of southern Russia.) Odessa.
Zeits. Kolonialpol., Berlin.	Zeitschrift für Kolonialpolitik, Kolonialrecht und Kolonialwirtschaft. Berlin.

CORRIGENDUM.

1896.

Schierbeck, N. P.
Sur la vitesse de l'évaporation au point de vue spécial des relations physiologiques. Overs. k. Danske Forhandl., 1896, No. 1, 30 p. Abstract in Fortsch. der Phys., 1896, **25**, pt. ii: 308-9.

Investigates the relation between rate of evaporation and the condition of the atmosphere, using the formulas of Dalton and Stefan; his experiments confirm the Stefan formula. He finds the coefficient of evaporation directly proportional to the absolute temperature. The volume of vapor passing through a cross section of unit area in a unit of time at a temperature of 0° C. and pressure of 760 millimeters is expressed by the equation

$$v = K/h \,.\, \log \frac{B-f}{B-f_1},$$

where B=air pressure, h=height of the pan's rim above the water surface, f=vapor pressure at temperature of the air, f_1=vapor pressure at the temperature of evaporation, K=constant.

Also finds that the evaporation is proportional to the square root of the rate of boiling; and that the difference $f-f_1$ is not a measure of the rate of evaporation. The drying power of a climate is expressed by

$$\log \frac{B-f}{B-f_1}\,(1+a\,t)\,w^{\frac{1}{2}},$$

f_1 to be measured by the highest grade thermometers, w=wind velocity.

ADDENDA.

CHRONOLOGICAL OUTLINE OF METEOROLOGY IN THE UNITED STATES.

1881. January. Gen. W. B. Hazen (b. 1830, d. 1887), succeeded Generals Myer, and Drum, as Chief Signal Officer.

1898. July 7. The United States Congress enacted the act appropriating money for the West Indies storm-warning service. Its headquarters were first established at Kingston, Jamaica, W. I., and the first reports from the newly established stations were received on August 9 of this year. The headquarters of this service were removed to Habana, Cuba, on February 1, 1899.

1900. Early in this year Father José Algué and Prof. W. L. Moore arranged with the Secretary of Agriculture, the President of the United States, and the President of the first Phil-

lipine Commission (Schurmann), for the establishment of the Phillipine Weather Bureau, with its headquarters at Manila.

1901. May 22. The Phillipine Weather Bureau was established by the act of the second United States Phillipine Commission (W. H. Taft, Chairman). See MONTHLY WEATHER REVIEW, 1901, 29:372-4.

CORRIGENDA.

In the MONTHLY WEATHER REVIEW for April, 1909, p. 148, column 2, paragraph 5 from the bottom change the date of founding of Blue Hill Observatory from 1880 to 1885; in the MONTHLY WEATHER REVIEW for May, 1909, p. 178, column 1, at the bottom of the page, insert "1885. Blue Hill Observatory founded by A. L. Rotch."

In MONTHLY WEATHER REVIEW, May, 1909, p. 196, column 1, under "1903," second title, for "Pasoeroean" read "Pasuruan."

THE ZODIACAL LIGHT.

The MONTHLY WEATHER REVIEW has several times published notes and articles bearing on the nature of the zodiacal light. The latest researches on this phenomenon may still have some interest for our readers.

The University of California[1] has just published the results of a careful photospectroscopic study by E. A. Fath, made during the autumns of 1907 and 1908 on Mount Hamilton, and under very favorable conditions during September, 1909, on Mount Wilson. The observations on Mount Hamilton yielded negatives of fairly good quality, using a slit-width of 0.38 millimeter and securing a spectrum on the plate of about 2.2 millimeters between $\lambda = 5{,}000$ and $\lambda = 3{,}900$. The spectrum negatives were not strong enough to definitely prove the presence or absence of the suspected absorption lines at about $\lambda = 4{,}300$ and $\lambda = 3{,}950$.

The Mount Wilson negatives, obtained with a slit-width of 0.41 millimeter which did not resolve the H and K lines of the solar spectrum, exactly resembled the solar spectrum and were much stronger than those obtained in 1907 on Mount Hamilton, but not sufficiently so for reproduction. However, they showed with certainty the two absorption lines.

Mr. Fath says:

> A comparison of this plate with one of the sky spectrum taken with the same slit-width [0.41 millimeter] shows these lines to be G and the blend of H and K of the solar spectrum. These are the only lines shown on the sky comparison plate within the limits of the spectrum obtained on the Zodiacal Light plate. There is no indication of bright lines on any of the spectrograms of the Zodiacal Light. Thus, in so far as spectra of such low dispersion and resolving power can be trusted, we would seem to have good evidence to support the claim that the Zodiacal Light is reflected sunlight.—*C. A., jr.*

[1] Lick Observatory Bulletin, No. 165. [Dated October, 1909.]

THE WEATHER OF THE MONTH.

By Mr. P. C. DAY, Acting Chief, Climatological Division.

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure for June, 1909, over the United States and Canada is graphically shown on Chart VI, and the average values and departures from the normal are shown for each station in Tables I and III.

The general distribution of the mean atmospheric pressure for the month compared favorably with the normal. Pressure slightly above normal prevailed over the more northerly districts of the United States and the western portions of Canada, the maximum excess, about 0.10 inch, occurring in the upper Missouri Valley, and pressure slightly below normal obtained over the Canadian Maritime Provinces and portions of New England.

From May to June there was a general and rather uniform increase in pressure over all districts of the United States, except along the Pacific coast and also over the whole of Canada, except in parts of the St. Lawrence Valley. Over the interior districts the increase ranged from 0.05 to 0.10 inch, with maximum values over the upper Mississippi and middle Missouri valleys.

The storm tracks were somewhat erratic in their direction of movement and were as a rule but shallow depressions having their origin in most cases over the eastern slopes of the Rocky Mountains. West of the mountains the month was unusually free from decided atmospheric pressure variations.

Warm southerly winds occurred at frequent intervals over nearly all districts east of the Rocky Mountains and the prevailing direction of the winds for the month over those districts was from some southerly point.

On the Pacific coast northwesterly winds predominated, and the prevailing winds were from the north along the northern border as far east as the Great Lakes. Over the greater portion of the region from the Great Lakes and lower Mississippi Valley westward, the wind movement was decidedly sluggish, especially over portions of the Great Plains where the average velocity ranged from 20 to as much as 50 per cent less than the normal. Over the Atlantic coast and Gulf States there was a general but not large increase of wind velocity, the excess ranging from 10 to 30 per cent.

TEMPERATURE.

The mean temperature for the month as a whole was close to the normal, although during several periods there were decided variations both above and below the usual seasonal temperature.

During the first week the temperature averaged well above the normal in all districts, except over portions of the lower Mississippi Valley and in northern New England. The week was decidedly warm over the central and southern portions of the Plateau and Pacific coast districts, the excess above the normal ranging from 6° to 9° per day. The day temperatures were high also in the above districts, the maximum temperatures exceeding 100° over large portions of the southwest and exceeding by several degrees any previous record for the same season of the year at a number of points.

The second week was generally cool over all northern and western districts, the mean temperature over the Missouri and upper Mississippi valleys, and northern Rocky Mountain regions, ranging from 6° to 9° below the normal.

Over the South Atlantic and Gulf States it was somewhat warmer than the normal, and there was a slight excess along the north Pacific coast. No unusual extremes of temperature occurred except over northern New England, where temperatures close to freezing occurred and also at exposed points in the mountain regions of the West.

During the third week there was a considerable warming up over the northern districts from the Great Lakes westward to the Pacific, and in the Great Plains region, and it continued warm over the greater part of the Gulf States. The weather continued cool over the southwest and portions of the Lake region and New England.

There was a marked increase in temperature during the last week of the month over all districts east of the Rocky Mountains, the mean temperatures for the week ranging from 6° to 9° above the normal over the Lake region, New England and Middle Atlantic States, and somewhat less over the remaining districts. High day temperatures prevailed during most of the week, and the night temperatures were frequently oppressive. There was a decided warming up also over the South-

west, but along the northern border from North Dakota westward to the Pacific the week was comparatively cool.

PRECIPITATION.

June was a month of generally heavy and well-distributed rainfall over nearly all districts east of the Rocky Mountains, the only marked exceptions being in portions of New England, where the rainfall was light during the latter part of the month, over portions of the Florida Peninsula, where the fall though light was generally sufficient for the needs of growing vegetation, and locally in portions of Arkansas, Oklahoma, and Texas, where the amounts for the several weeks were insufficient.

West of the Rocky Mountains there was a general deficiency, though the lack of precipitation was not seriously felt on account of the general excess of moisture in the soil from the heavy precipitation earlier in the season, and the abundant supply of water available in the streams for irrigation, except in portions of Arizona and New Mexico where the lack of rainfall with attendant hot weather seriously damaged pasturage on the ranges.

The total precipitation for the month ranged from 6 to 10 inches in portions of eastern Colorado and western Kansas, in the middle Mississippi and lower Missouri valleys, and over large portions of the southern Appalachian Mountain region and the east Gulf States; elsewhere over the districts east of the Rocky Mountains the monthly amounts were generally from 2 to 4 inches. Over the main ranges of the Rocky Mountains and along the north Pacific Coast the amounts were generally from 1 to 2 inches, while over the Plateau and Pacific coast States, except along the coast of Oregon and Washington, the total fall for the month was generally less than 0.5 of an inch, and in large portions of southern California not more than traces occurred.

Some snow occurred in the high ranges of the Sierra and Rocky Mountains, the total fall at local points in Colorado and Wyoming amounting to 10 and in some cases to 20 inches.

High waters were general in the mountain districts due to the melting of the large accumulation of snow during the past winter, and water for irrigation purposes was generally plentiful.

The month was remarkably free from severe storms, although some damage resulted from a series of tornadoes in Missouri on the 22d and in Kansas on the 24th.

HUMIDITY AND SUNSHINE.

The relative humidity was above the normal from 5 to 10 per cent over most of the interior portions of the country east of the Rocky Mountains, except in portions of Texas and adjoining portions of Louisiana and Oklahoma. The relative humidity was below the normal over New England and generally over the Plateau and north Pacific coast districts.

Much cloudy weather prevailed during the month over all districts, except in portions of the Southwest and from the upper Lakes westward to Montana, where sunshine was generally above the average. Over large portions of the Appalachian Mountain region and Ohio Valley the percentage of sunshine was not much above 30 per cent of the possible.

In Canada.—Director R. F. Stupart says:

The temperature was generally and uniformly a little above the average throughout the Dominion, the positive departure in nearly all districts varying from 1° to 2°, although in isolated localities it was as much as 3°.

The rainfall was very deficient in nearly all portions of the Dominion, except in a few isolated localities, noticeably in the Gaspe Peninsula, and in the extreme southwestern portion of Saskatchewan, where for the most part the usual quantity appears to have been well exceeded. Ottawa City recorded an amount in excess of the average, also a few places in the extreme southwestern counties of Ontario, in each instance owing to the prevalence of thunderstorms in the localities affected. In British Columbia the negative departure varied from six-tenths of an inch to three inches. In the Western Provinces the deficit was very genreally from one to two inches, in Ontario from one and a quarter to two inches and a half, in Quebec, from three-fourths of an inch to over two inches, and in the Maritime Provinces from one-half to nearly three inches.

Average temperatures and departures from the normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since. January 1.	Average departures since January 1.
		°	°	°	°
New England	12	64.6	+ 1.0	+ 5.1	+ 0.8
Middle Atlantic	16	71.2	+ 1.0	+11.9	+ 2.0
South Atlantic	10	77.7	+ 1.6	+12.5	+ 2.1
Florida Peninsula	8	80.9	+ 1.2	+15.4	+ 2.6
East Gulf	11	78.9	+ 0.8	+ 7.2	+ 1.2
West Gulf	10	79.6	+ 0.8	+ 8.5	+ 1.4
Ohio Valley and Tennessee	13	73.9	+ 0.7	+ 7.9	+ 1.3
Lower Lakes	10	66.2	− 0.7	+ 4.2	+ 0.7
Upper Lakes	12	62.9	+ 0.8	+ 4.8	+ 0.8
North Dakota*	9	63.1	+ 0.5	− 3.4	− 0.6
Upper Mississippi Valley	14	70.6	− 0.2	+ 2.6	+ 0.4
Missouri Valley	12	70.8	− 0.2	+ 3.0	+ 0.5
Northern slope	9	62.2	+ 0.1	− 4.6	− 0.8
Middle slope	6	72.2	+ 0.5	+ 1.8	+ 0.3
Southern slope	8	77.6	+ 0.8	+ 7.6	+ 1.3
Southern Plateau*	11	73.2	+ 0.8	− 4.2	− 0.7
Middle Plateau*	11	65.5	+ 1.9	+ 2.6	+ 0.4
Northern Plateau*	12	62.2	+ 0.1	− 1.4	− 0.2
North Pacific	7	57.1	− 0.4	− 6.7	− 1.1
Middle Pacific	5	62.9	− 1.4	− 0.1	0.0
South Pacific	4	65.5	− 0.6	− 0.2	0.0

*Regular Weather Bureau and selected cooperative stations.

Average precipitation and departures from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
		Inches.		Inches.	Inches.
New England	11	2.64	87	− 0.40	+ 2.10
Middle Atlantic	16	4.38	122	+ 0.80	+ 0.20
South Atlantic	11	5.36	110	+ 0.50	− 2.00
Florida Peninsula*	8	7.56	114	+ 0.90	− 0.90
East Gulf	11	7.20	160	+ 2.70	+ 7.80
West Gulf	10	2.63	72	− 1.10	− 6.50
Ohio Valley and Tennessee	13	5.25	124	+ 1.00	+ 3.70
Lower Lakes	10	2.87	80	− 0.70	+ 3.30
Upper Lakes	12	2.84	83	− 0.60	+ 0.60
North Dakota*	9	2.99	81	− 0.70	− 0.40
Upper Mississippi Valley	15	3.70	86	− 0.60	+ 2.30
Missouri Valley	12	4.76	107	+ 0.30	+ 1.40
Northern slope	9	3.54	151	+ 1.20	+ 0.50
Middle slope	6	3.00	94	− 0.20	− 1.70
Southern slope*	8	3.14	89	− 0.40	− 4.40
Southern Plateau*	10	0.17	46	− 0.20	− 1.40
Middle Plateau*	11	0.24	44	− 0.30	− 0.60
Northern Plateau*	12	1.30	100	0.00	− 0.80
North Pacific	7	0.96	47	− 1.10	− 2.50
Middle Pacific	7	0.08	28	− 0.20	+ 6.70
South Pacific	4	0.05	100	0.00	+ 5.20

*Regular Weather Bureau and selected cooperative stations.

Average relative humidity and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	73	− 6	Missouri Valley	74	+ 7
Middle Atlantic	75	− 2	Northern slope	65	+ 8
South Atlantic	81	+ 3	Middle slope	67	+ 7
Florida Peninsula	80	0	Southern slope	58	+ 2
East Gulf	78	+ 3	Southern Plateau	32	+ 2
West Gulf	76	0	Middle Plateau	35	− 2
Ohio Valley and Tennessee	76	+ 6	Northern Plateau	51	0
Lower Lakes	72	+ 1	North Pacific	71	− 5
Upper Lakes	74	+ 1	Middle Pacific	64	+ 2
North Dakota	74	+ 6	South Pacific	66	0
Upper Mississippi Valley	75	+ 5			

Average cloudiness and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	5.1	− 0.1	Missouri Valley	5.2	+ 0.3
Middle Atlantic	5.7	+ 0.7	Northern slope	4.9	+ 0.1
South Atlantic	5.6	+ 0.6	Middle slope	4.7	+ 0.7
Florida Peninsula	5.6	+ 0.4	Southern slope	4.4	+ 0.6
East Gulf	5.5	+ 0.8	Southern Plateau	1.6	− 0.4
West Gulf	4.2	− 0.1	Middle Plateau	2.8	− 0.5
Ohio Valley and Tennessee	6.0	+ 1.0	Northern Plateau	4.8	+ 0.2
Lower Lakes	5.1	+ 0.2	North Pacific	5.0	− 1.1
Upper Lakes	5.2	+ 0.1	Middle Pacific	3.5	+ 0.2
North Dakota	4.6	− 0.8	South Pacific	3.6	+ 0.3
Upper Mississippi Valley	5.8	+ 0.8			

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
El Paso, Tex	25	54	ne.	Pt. Reyes Light, Cal	2	54	nw.
Modena, Utah	18	60	sw.	Do	4	54	nw.
Mt. Tamalpais, Cal	11	60	nw.	Do	5	53	nw.
Do	14	80	nw.	Do	11	64	nw.
Do	23	50	nw.	Do	12	60	nw.
Do	25	64	nw.	Do	13	72	nw.
Do	26	54	nw.	Do	14	61	nw.
North Head, Wash	27	64	se.	Do	25	76	nw.
Oklahoma, Okla	29	50	n.	Do	26	65	nw.
Pierre, S. Dak	20	51	sw.	Do	27	54	nw.
Pittsburg, Pa	27	52	w.	Do	28	53	nw.
Pt. Reyes Light, Cal	1	54	nw.	Do	29	50	nw.

RAINFALL IN JAMAICA.

Through the kindness of Mr. Maxwell Hall, meteorologist to the government of Jamaica and now in charge of the meteorological service of that island, we have received the following data:

The rainfall for the island for the month of June was a little above the average. The greatest rainfall, 20.39 inches, was recorded at Brownsville, Hanover. The least rainfall, 1.09 inches, was recorded at Southfield, St. Anns.

Comparative table of rainfall.

[Based upon the average stations only.]

JUNE, 1909.

Divisions.	Relative. area.	Number of stations.	Rainfall. 1909.	Rainfall. Average.
			Inches.	*Inches.*
Northeastern division	25	17	4.98	6.59
Northern division	22	41	5.22	4.33
West-central division	26	20	9.46	8.33
Southern division	27	26	6.01	5.20
Means	100	....	6.42	6.11

CLIMATOLOGICAL SUMMARY.

By Mr. P. C. DAY, Acting Chief, Climatological Division.

TEMPERATURE AND PRECIPITATION BY SECTIONS, JUNE, 1909.

In the following table are given, for the various sections of the Climatological Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting the greatest and least monthly precipitation, and other data, as indicated by the several headings.

The mean temperatures for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperature and precipitation are based only on records from stations that have ten or more years of observations. Of course the number of such records is smaller than the total number of stations.

Section.	Temperature—Section average.	Departure from the normal.	Monthly extremes: Station.	Highest.	Date.	Station.	Lowest.	Date.	Precipitation—Section average.	Departure from the normal.	Greatest monthly: Station.	Amount.	Least monthly: Station.	Amount.
Alabama	78.0	0.0	Flomaton	100	18	Madison Scottsboro	53 53	3 1	7.82	+ 3.55	Guntersville	14.28	Uniontown	3.16
Arizona	78.1	− 0.6	Mohawk Summit	121	30	Flagstaff, B	27	21	0.16	− 0.04	Dos Cabezos	1.44	17 stations	0.00
Arkansas	76.9	+ 0.2	Pocahontas	104	8	Dutton	49	4	4.08	− 0.17	Mammoth Spring	8.68	Newport, No. 2	1.26
California	68.1	− 1.1	Mammoth Tank	115	30	Tamarack Truckee	21 21	2 1	0.19	− 0.15	North Bloomfield	2.00	50 stations	0.00
Colorado	61.8	+ 0.2	Las Animas	107	28	Wagon Wheel Gap	20	9, 20	1.51	+ 0.41	Cheyenne Wells	8.62	River Portal	0.00
Florida	80.7	+ 0.8	Johnstown	102	14	Middleburg	56	1	6.28	− 0.69	Tarpon Springs	18.10	Carrabelle	1.65
Georgia	78.5	+ 0.5	Blakely	104	17	Diamond	55	5	5.48	+ 0.96	Clayton	14.65	Helena, Montezuma	1.86
Hawaii (May)	70.6	......	3 stations	90	3 d't's	Humuula, Hawaii	35	3, 18	5.24	......	Honomanu Valley	23.74	3 stations	0.00
Hawaii (June)	72.0	......	Kibei	90	5, 26	Humuula, Hawaii	35	11	4.26	......	Honomanu Valley	21.21	3 stations	0.00
Idaho	61.6	+ 1.9	Garnet	103	30	Forney	26	6	0.70	− 0.41	Bonners Ferry	2.43	2 stations	0.00
Illinois	72.7	+ 0.4	Chester, Mt. Vernon	98	3 d't's	6 stations	39	3 d't's	4.15	+ 0.41	Robinson	8.75	Du Quoin	1.34
Indiana	72.2	+ 0.7	Rome	97	28	Auburn	39	19	5.16	+ 1.08	Rochester	9.02	Greensburg	2.34
Iowa	69.1	+ 0.3	Keosauqua	96	26	Elma	40	15	6.41	+ 1.89	Afton	13.30	Davenport	2.80
Kansas	73.1	+ 0.3	Lakin	104	29	Colby	42	3	5.45	+ 0.90	Wakeeney	12.07	Coolidge	0.79
Kentucky	74.5	+ 0.4	Calhoun	99	28	Maysville	43	19	5.05	+ 0.71	Berea	10.20	Blandville	2.31
Louisiana	81.9	+ 0.3	Opelousas	103	16	Monroe	54	2	6.51	+ 1.21	Pearl River	16.50	Minden	1.44
Maryland and Delaware	71.8	+ 1.1	Cambridge, Md Millsboro, Del	98 98	25 25	Deer Park, Md	32	18	5.04	+ 1.01	Bachmans V'y, Md	10.45	Clear Spring, Md	2.72
Michigan	64.3	+ 0.5	Powers	96	13	Chatham Wetmore	28 28	18 8, 18	3.15	+ 0.13	Grand Rapids	7.50	St. Ignace	0.30
Minnesota	65.0	+ 0.5	Baudette	97	19	International Falls	29	14	3.53	− 0.73	New Ulm	8.30	Floodwood	0.72
Mississippi	78.6	− 0.2	Duck Hill	100	27, 28	5 stations	60	5 d't's	6.53	+ 2.91	Pearlington	16.09	Hernando	1.95
Missouri	73.9	+ 0.5	Caruthersville	98	27	Sublett	48	18	5.21	+ 0.43	Gallatin	10.05	Cape Girardeau	0.74
Montana	59.4	+ 1.2	Bridger	103	29	Bowen	24	6	3.02	+ 0.08	Highwood	6.89	Homepark	0.46
Nebraska	69.0	+ 0.4	Beaver City	108	29	Kimball	33	11	4.26	+ 0.41	Westpoint	9.94	Greeley	0.55
Nevada	65.5	+ 2.3	Logan	112	30	Cobre	24	9	0.28	− 0.14	Lovelock	1.95	8 stations	0.00
New England*	64.9	+ 0.4	W. Ossipee, N. H	100	25	Van Buren, Me	20	2	2.58	− 1.04	Alstead Center, N.H.	4.68	Provincetown, Mass	0.69
New Jersey	70.0	+ 0.8	Somerville	99	25	Rivervale	36	19	3.26	− 0.55	Cape May C. H.	5.70	Runyon	1.71
New Mexico	70.0	+ 0.1	Gage	104	25	Elizabethtown	23	9	0.91	− 0.30	Dorsey (near)	5.21	3 stations	0.00
New York	65.1	+ 0.6	Bedford	99	25	Nehasane	21	8	2.86	− 0.85	Newark Valley	6.15	Chazy	0.65
North Carolina	75.9	+ 1.6	Goldsboro	99	26, 28	Banners Elk	42	19	7.92	+ 2.91	Newbern	17.05	Wilmington	2.57
North Dakota	62.9	+ 0.6	Bismarck Medora	98 98	28 22	Berthold Agency	28	14	3.21	− 0.38	Amenia	7.65	Portal	1.10
Ohio	70.1	+ 0.8	Ironton, Waverly	96	27	Rome	36	16	5.86	+ 1.91	Benton Ridge	12.70	Sidney	2.63
Oklahoma	76.5	+ 0.9	Beaver Chickasha	104 104	6 17	5 stations	50	3 d't's	3.45	− 0.52	Chattanooga	8.87	Wagoner	1.11
Oregon	59.4	+ 0.4	3 stations	100	4 d't's	Christmas Lake	20	8	0.66	− 0.94	Bay City	2.34	Hood River	T.
Pennsylvania	68.8	+ 0.8	Philadelphia, C	96	26	Saegerstown	34	16	4.48	+ 0.31	State College	8.96	Milford	1.89
Porto Rico	77.8	− 0.5	Bayamon	96	1	Jayuya Maricao	58 58	6 3	7.63	+ 0.62	San Sebastián	18.54	Jayuya	2.46
South Carolina	79.2	+ 1.2	Florence	105	27	Darlington	58	16	6.87	+ 1.82	Anderson	12.42	Charleston	1.64
South Dakota	66.9	+ 1.5	Cascade Springs	103	29	Pollock	34	14	4.10	− 0.33	Dumont	9.65	Chamberlain	0.63
Tennessee	75.6	+ 0.6	Jackson	99	24, 29	Mountain City	43	19	5.44	+ 1.18	Charleston	13.83	Memphis	1.78
Texas	80.9	+ 1.2	Brownwood	107	28	Claude	44	1, 3, 4	3.37	− 0.35	Bridgeport	10.75	El Paso	0.05
Utah	66.2	+ 1.3	Green River	110	30	Scofield	20	10	0.14	− 0.36	Government Creek	0.79	10 stations	0.00
Virginia	73.0	+ 1.3	Lincoln	98	26	Burkes Garden	35	19	6.24	+ 1.93	Elk Knob	10.76	Shenandoah	2.70
Washington	61.0	0.0	Cheney	102	29	Clealum	25	28	0.90	− 0.96	Quiniault	4.43	Kennewick	0.06
West Virginia	71.1	+ 1.9	Sutton	101	27	Arbovale, Bayard	35	19	5.73	+ 1.16	Terra Alta	9.19	Lewisburg	2.47
Wisconsin	65.0	− 0.3	Neillsville Muscoda	99 99	29 30	Long Lake	29	18	3.93	− 0.14	Stanley	7.61	Herbster	0.87
Wyoming	58.9	+ 1.1	Basin	103	29	Kirwin	22	11	2.27	+ 0.74	Wyncote	5.98	Snake River, Y. N. P	0.07

*Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

TABLE I.—*Climatological data for U. S. Weather Bureau stations, June, 1909.*

Stations.	Elevation of instruments. Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Pressure, in inches. Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Temperature of the air, in degrees Fahrenheit. Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches. Total.	Departure from normal.	Days with .01, or more.	Wind. Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
New England.							64.6	+ 1.0										73	2.64	− 0.4										5.1	
Eastport	76	67	85	29.82	29.90	− .03	57.4	+ 3.0	86	26	68	36	2	47	38	52	48	77	1.59	− 1.6	9	6,036	s.	32	se.	18	4	16	10	6.3	
Greenville	1,070	6		28.78	29.93		59.4		84	24	72	29	2	46	47				3.60		11										
Portland, Me.	103	81	117	29.82	29.94	− .01	65.0	+ 2.4	93	22	74	44	2	56	32	58	52	67	2.33	− 1.0	9	6,258	s.	36	nw.	29	8	15	7	5.0	
Concord	288	70	79	29.65	29.96	.00	65.8	+ 1.4	92	22	78	41	8	53	35				3.12	− 0.2	8	3,864	nw.	23	w.	18	24	4	2	2.6	
Burlington	404	11	48	29.52	29.95	− .01	64.4	+ 0.6	88	24	74	40	8	54	32				3.57	+ 0.3	8	6,972	s.	38	s.	17	7	13	10	5.6	
Northfield	876	16	70	29.03	29.96	.00	61.3	− 1.4	88	22	74	33	8	49	36	56	51	68	2.94	− 0.3	11	5,447	s.	30	se.	17	8	18	4	5.1	
Boston	125	115	188	29.83	29.96	.00	69.4	+ 3.6	94	25	78	49	9	61	26	61	56	67	4.45	+ 1.4	8	7,121	w.	30	nw.	18	10	9	11	5.6	
Nantucket	12	14	90	29.95	29.96	− .02	61.4	+ 0.1	84	26	68	46	9	55	22	58	56	87	2.30	− 0.1	12	11,416	sw.	48	ne.	6	13	7	10	5.2	
Block Island	26	11	46	29.94	29.97	.00	63.0	+ 1.4	85	26	69	48	9	57	18	58	56	84	1.43	− 1.4	11	10,982	sw.	42	n.	5	21	3	6	3.9	
Narragansett		9					63.5	− 0.7	90	26	72	45	2	55	27				2.02		10		sw.				20	5	5		
Providence	160	141	165	29.80	29.97	.00	67.4	− 0.9	92	25	77	44	9	58	27	60	55	68	1.61	− 1.4	9	6,863	nw.	41	nw.	18	7	19	4	5.1	
Hartford	159	122	140	29.80	29.97	.00	68.2	+ 1.1	92	25	78	44	9	59	28	60	55	65	2.23	− 0.8	11	5,078	s.	29	nw.	18	5	16	9	6.0	
New Haven	106	116	155	29.85	29.96	− .01	68.8	+ 1.9	93	25	78	49	19	60	26	61	56	70	3.47	+ 0.3	11	5,620	s.	26	nw.	18	11	13	6	4.9	
Mid. Atlantic States.							71.2	+ 1.0										75	4.38	+ 0.8										5.7	
Albany	97	102	115	29.86	29.96	− .01	68.7	+ 0.8	94	25	79	46	19	58	31	60	55	66	2.74	− 1.0	11	4,715	s.	29	s.	17	11	13	6	5.0	
Binghamton	871	78	90	29.07	29.99	+ .02	65.8	− 0.4	87	25	76	43	16	56	34				3.52	− 0.1	10	3,213	nw.	24	nw.	18	4	8	18	7.3	
New York	314	108	350	29.64	29.97	− .01	70.5	+ 2.0	92	25	78	53	19	63	24	63	58	70	3.17	− 0.1	12	7,014	sw.	43	w.	18	7	12	11	6.0	
Harrisburg	374	94	104	29.59	29.99	.00	70.4	+ 0.1	90	26	79	52	19	62	30	64	60	72	4.26	+ 0.7	15	3,835	w.	34	nw.	25	5	15	10	6.3	
Philadelphia	117	116	184	29.87	29.99	+ .01	72.8	+ 1.6	94	25	80	54	10	65	24	65	61	71	2.26	− 1.0	13	6,170	s.	27	se.	17	5	13	12	6.3	
Scranton	805	111	119	29.14	29.99	+ .01	68.0	+ 0.8	90	22	77	47	16	59	33	62	58	71	5.85	+ 2.3	14	3,434	sw.	23	nw.	18	10	11	9	5.5	
Atlantic City	52	37	48	29.93	29.98	.00	68.2	+ 1.4	91	24	74	51	19	62	24	63	61	81	2.49	− 0.5	17	5,065	sw.	25	ne.	6	5	10	15	7.1	
Cape May	17	48	52	29.99	30.01	+ .03	68.1	+ 0.4	89	23	74	56	10	63	21	65			3.48	+ 0.4	16	4,833	s.				9	12	9	5.4	
Baltimore	123	100	113	29.86	29.98	− .01	74.1	+ 1.1	94	25	82	56	19	67	27	67	63	71	4.38	+ 0.5	13	4,325	sw.	25	sw.	22	4	12	14	6.8	
Washington	112	62	85	29.87	29.98	− .02	73.4	+ 0.7	94	26	82	51	19	65	30	67	64	76	3.82	− 0.4	12	3,718	sw.	30	nw.	14	10	12	8	5.4	
Cape Henry	18	9	58	29.98	30.00	.00	74.4	+ 1.5	92	28	81	56	7	67	20				6.26	+ 1.8	19	7,934	sw.	39	nw.	29	12	9	9	5.0	
Lynchburg	681	83	88	29.28	30.01	.00	75.4	+ 1.9	94	28	85	52	19	66	27	69	66	81	4.95	+ 1.1	17	2,437	sw.	28	n.	11	4	21	5	5.8	
Mount Weather	1,725	10	54	28.21	29.98	− .02	68.4	+ 0.9	85	27	75	48	19	62	22	63	60	80	5.91	+ 1.1	17	7,373	nw.	36	nw.	18	6	14	10	5.9	
Norfolk	91	102	111	29.91	30.01	+ .01	75.8	+ 1.4	92	25	84	59	7	68	23	70	67	80	6.00	+ 1.7	19	6,212	s.	48	nw.	5	8	13	9	5.5	
Richmond	144	145	153	29.86	30.00	− .01	76.2	+ 1.1	95	25	86	57	19	66	27				4.59	+ 1.1	16	5,091	s.	48	nw.	10	14	10	6	4.6	
Wytheville	2,293	40	47	27.70	30.00	− .01	69.8	+ 1.1	88	27	80	45	19	60	33	64	62	85	6.33	+ 2.2	16	2,901	w.	22	w.	17	12	17	1	3.9	
S. Atlantic States.							77.7	+ 1.6										81	5.36	+ 0.5										5.6	
Asheville	2,255	53	75	27.72	30.01	.00	71.2	+ 2.5	88	26	81	53	19	62	27	66	65	91	7.74	+ 3.4	21	3,938	se.	28	e.	8	2	12	16	7.0	
Charlotte	773	68	76	29.20	30.02	+ .01	76.6	+ 1.1	94	25	85	63	19	68	24	70	67	79	7.04	+ 2.6	14	4,006	sw.	23	nw.	14	3	22	5	6.1	
Hatteras	11	12	47	30.02	30.03	+ .02	76.0	+ 1.6	86	28	81	63	6	71	16	73	72	88	4.17	− 0.2	9	9,597	sw.	44	w.	15	18	8	4	3.7	
Manteo	12	12	46				75.6	+ 0.5	90	24	82	60	8	69					7.04	+ 2.7	11		s.				17	10	3		
Raleigh	376	103	110	29.62	30.00	− .01	77.4	+ 2.3	94	25	87	62	20	68	26	70	67	78	5.73	+ 1.0	11	5,249	sw.	33	w.	17	5	19	6	5.7	
Wilmington	78	81	91	29.96	30.04	+ .03	78.0	+ 2.5	91	1	85	61	7	71	22	73	71	81	2.57	− 3.0	11	5,990	sw.	34	sw.	4	5	20	6	5.5	
Charleston	48	14	92	29.98	30.03	+ .02	80.4	+ 1.9	92	13	86	68	6	75	21	74	72	79	1.64	− 3.8	9	7,429	s.	34	sw.	4	9	15	6	5.0	
Columbia, S. C.	351	41	57	29.64	30.01	.00	79.0	+ 0.8	94	14	88	65	6	70	24	71	68	75	6.67	+ 2.5	13	4,397	sw.	27	sw.	4	3	15	12	6.6	
Augusta	180	89	97	29.82	30.01	.00	79.4	+ 1.3	93	14	88	66	6	71	22	72	69	77	5.19	+ 0.7	11	3,920	se.	38	s.	3	4	15	11	6.2	
Savannah	65	81	89	29.96	30.03	+ .02	80.2	+ 2.0	96	13	87	68	8	73	22	74	71	80	2.22	− 3.8	9	5,604	se.	27	s.	30	10	11	9	5.4	
Jacksonville	43	96	129	29.98	30.02	+ .01	80.4	+ 1.4	94	12	88	67	20	73	21	75	74	85	8.93	+ 3.4	15	6,539	se.	42	s.	19	10	15	5	4.8	
Florida Peninsula.							80.7	+ 0.2										80	7.53	+ 1.6										5.6	
Jupiter	28	10	46	29.97	30.00	− .01	80.4	+ 0.4	91	4	86	69	9	75	18	75	73	80	4.35	− 2.6	25	8,294	se.	36	e.	8	2	26	2	5.5	
Key West	22	10	53	29.96	29.98	− .01	80.8	− 1.4	90	4	86	69	28	75	17	76	74	79	9.71	+ 5.5	19	6,654	e.	32	nw.	28	2	20	8	6.2	
Sand Key	25	41	71	29.94	29.98	− .01	80.4		92	10	84	68	28	76	20				4.76	+ 0.5	15	10,021	se.	47	e.	23	7	18	5	5.0	
Tampa	35	79	96	29.97	30.00	− .01	81.0	+ 2.3	94	1	89	69	22	73	22	74	72	81	11.31	+ 3.0	17	5,673	ne.	40	sw.	29	6	18	6	5.5	
East Gulf States.							78.9	+ 0.8										78	7.20	+ 2.7										5.5	
Atlanta	1,174	190	216	28.81	30.02	+ .01	76.7	+ 1.1	94	25	85	64	5	68	23	69	66	76	4.43	+ 0.6	13	6,676	e.	30	w.	10	8	10	12	6.2	
Macon	370	78	87	29.62	30.01	.00	79.5	+ 2.4	94	25	88	66	6	71	24				2.49	− 1.1	11	3,749	se.	31	s.	3	9	12	9	5.6	
Thomasville	273	8	57	29.71	30.00	.00	80.6	+ 1.1	97	15	91	63	9	70	29	72	70	77	11.10	+ 6.4	11	3,565	e.	28	sw.	19	13	11	6	4.4	
Pensacola	56	79	96	29.93	29.99	.00	80.0	0.0	92	25	86	70	2	74	20				6.03	+ 1.2	9	6,717	se.	44	se.	3	10	14	6	5.0	
Anniston	741	9	57	29.25	30.03	+ .03	76.6	+ 1.6	92	28	86	60	1	67	28				7.69	+ 3.8	18	3,188	se.	30	w.	1	2	15	13	7.1	
Birmingham	700	11	48	29.26	30.01	+ .02	77.2	− 1.0	93	28	85	62	1	69	22	71	69	80	8.04	+ 4.2	16	3,633	s.	30	nw.	14	2	23	5	5.4	
Mobile	57	98	106	29.92	29.98	− .01	80.3	+ 1.2	94	29	87	69	2	73	22	74	72	79	10.44	+ 4.5	13	4,721	se.	32	n.	18	6	19	5	5.2	
Montgomery	223	100	112	29.76	30.00	.00	79.2	+ 0.1	94	26	88	63	1	70	23	72	70	80	7.21	+ 3.0	14	3,594	se.	27	sw.	21	7	17	6	5.6	
Meridian	375	84	93	29.59	29.97	− .01	77.8	+ 0.5	92	26	87	62	1	69	24	71	69	78	7.93	+ 3.3	13	2,954	ne.	29	sw.	9	5	17	8	5.8	
Vicksburg	247	62	74	29.71	29.98	+ .01	78.8	+ 0.3	95	29	87	63	3	70	25	72	70	79	5.06	+ 0.6	16	3,621	e.	32	e.	29	10	13	7	5.2	
New Orleans	51	90	121	29.91	29.96	− .02	80.9	+ 1.3	93	17	88	70	2	74	19	74	72	77	8.82	+ 2.7	14	5,007	se.	28	nw.	4	13	9	8	4.9	
West Gulf States.							79.6	+ 0.8										76	2.63	− 1.1										4.2	
Shreveport	249	77	84	29.71	29.97	+ .01	80.3	+ 0.7	96	29	90	65	3	71	25	72	69	74	2.03	− 1.6	7	3,740	se.	30	ne.	17	17	10	3	3.6	
Bentonville	1303	11	44	28.61	29.95	+ .01	73.6	− 0.5	91	29	84	55	3	63	28				4.05	− 0.5	15	2,858	s.	22	ne.	29	10	12	8	5.0	
Fort Smith	457	79	94	29.48	29.95	+ .01	77.0	+ 0.2	94	29	86	62	13	68	25	69	66	76	3.02	− 1.0	14	4,392	e.	46	nw.	9	11	14	5	4.9	
Little Rock	357	139	147	29.60	29.97	+ .01	77.8	+ 0.6	93	28	86	62	1	70	22	70	68	78	2.81	− 1.3	13	4,419	sw.	36	w.	17	10	12	8	5.1	
Brownsville	57	4							99	29		67	2						3.72				s.								
Corpus Christi	20	69	77	29.90	29.92	+ .01	81.8	+ 1.2	94	29	87	69	2	76	22	76	74	80	1.50	− 1.2	5	11,252	se.	48	ne.	30	14	15	1	3.5	
Fort Worth	670	106	114	29.24	29.94	+ .02	81.4	+ 1.3	98	17	92	62	2	71	28				2.97	0.0	10	6,973	s.	40	nw.	18	15	15	0	3.4	
Galveston	54	106	112	29.90	29.96	+ .01	81.4	+ 0.5	91	5	86	69	14	77	16	75	73	78	3.08	− 1.7	7	7,538	se.	40	ne.	29	12	17	1	3.7	
Palestine	510	73	79	29.42	29.94	.00	79.4	+ 1.0	94	29	89	61	2	70	23	71	69	76	3.36	− 0.6	9	4.451	s.	28	ne.	29	5	14	11	6.0	
San Antonio	701	80	91	29.19	29.90	.00	82.8	+ 2.4	100	28	94	63	2	72	33	72	67	67	1.65	− 1.5	5	4,811	se.	31	n.	4	9	21	0	4.1	
Taylor	583	55	63	29.34	29.95	+ .03	81.0	+ 1.0	97	28	92	59	1	70	31				1.83	− 1.7	7	5,473	s.	28	sw.	22	20	8	2	3.1	
Ohio Val. and Tenn.							73.9	+ 0.7										76	5.25	+ 1.0										6.0	
Chattanooga	762	106	112	29.23	30.02	+ .02	75.8	+ 0.4	92	29	84	64	5	67	25	69	67	78	7.01	+ 2.7	18	3,634	sw.	28	nw.	14	3	16	11	6.4	
Knoxville	996	93	100	28.96	30.00	.00	74.8	+ 1.4	90	30	83	60	19	67	25	68	66	81	9.68	+ 5.5	17	3,003	sw.	25	sw.	9	5	10	15	6.2	
Memphis	399	76	97	29.58	30.00	+ .03	78.0	+ 0.3	92	27	85	65	1	71	21	71	68	75	1.78	− 2.6	10	4,656	sw.	48	nw.	17	9	12	9	5.5	
Nashville	546	168-	191	29.43	30.00	+ .01	76.4	+ 0.1	93	26	85	59	19	68	25	71	69	80	5.56	+ 1.2	12	4,985	sw.	48	s.	14	5	18	7	5.6	
Lexington	989	75	102	28.96	30.00	.00	72.8	− 0.4	90	27	81	55	19	64	24				5.41	+ 1.4	18	5,221	s.	35	n.	8	6	16	8	5.4	
Louisville	525	111	132	29.43	30.00	+ .02	76.6	+ 1.6	94	8	86	57	19	67	26	68	65	72	3.59	− 0.6	14	4,434	sw.	35	nw.	25	2	17	11	6.3	
Evansville	431	72	82	29.51	29.97	.00	76.2	+ 0.9	94	28	85	58	19	67	25				3.21	− 1.0	15	4,196	s.	26	s.	26	5	23	2	5.5	
Indianapolis	822	154	164	29.12	29.99	+ .02	72.1	− 0.3	89	29	81	49	15	63	28	65	62	74	5.21	+ 0.9	14	5,574	sw.	40	sw.	26	5	17	8	6.3	
Cincinnati	628	152	160	29.33	29.99	.00	74.2	+ 0.5	91	27	83	55	19	65	29	67	63	72	5.06	+ 1.1	13	3,833	se.	26	nw.	24	3	16	11	6.3	
Columbus	824	173	222	29.14	30.00	+ .01	71.8	+ 0.8	91	27	81	51	19	62	33	65	61	73	3.88	+ 0.4	14	6,189	sw.	42	nw.	24	7	8	15	6.5	
Pittsburg	842	336	352	29.10	29.99	.00	70.6	− 0.5	88	27	79	50	19	62	29	63	59	71	4.92	+ 1.0	16	5,117	sw.	52	w.	27	6	11	13	6.1	
Parkersburg	638	77	84	29.36	30.01	+ .01	72.9	+ 1.4	93	27	82	49	19	64	36	68	66	84	5.17	+ 0.5	17	2,824	sw.	34	nw.	8	11	10	9	5.3	
Elkins	1,940	41	50	28.01	30.00	.00	69.1	+ 2.5	91	27	80	40	19	58	38	63	61	82	7.78	+ 2.7	20	1,857	n.	23	w.	17	5	12	13	6.1	
Lower Lake Region.							66.2	− 0.7										72	2.87	− 0.7										5.1	
Buffalo	767	178	206	29.16	29.99	+ .02	64.6	− 0.5	88	27	71	45	18	58	25	59	56	76	1.05	− 2.1	5	8,473	sw.	40	sw.	18	5	13	12	6.1	
Canton	448	10	71	29.49	29.96		64.2	− 1.6	85	22	74	40	18	54	29				1.51	− 1.9	9	8,012	sw.	45	sw.	20	14	12	4	4.0	T
Oswego	335	76	91	29.60	29.96	− .01	63.1	− 0.7	85	23	71	45	18	56	26	58	52	71	2.40	− 1.0	9	5,623	w.	27	w.	18	11	11	8	4.6	
Rochester	523	86	102	29.43	29.99	+ .02	66.5	+ 0.4	87	23	75	46	18	58	29	58	52	62	0.91	− 2.2	6	5,290	w.	29	nw.	18	10	11	9	5.2	
Syracuse	597	97	113	29.35	30.00	+ .03	66.0	− 0.9	84	27	74	46	18	58	29				2.25	− 1.6	9	6,766	nw.	38	w.	18	9	15	6	5.2	
Erie	714	92	102	29.23	29.99	+ .01	66.2	− 0.8	85	21	73	47	16	60	27	60	57	73	2.58	− 1.2	14	5,451	w.	24	w.	14	7	8	15	6.3	
Cleveland	762	190	201	29.18	30.00	+ .02	66.8	− 1.1	86	24	73	50	16	60	23	61	57	71	3.72	0.0	13	7,141	se.	42	n.	17	10	12	8	5.1	
Sandusky	629	62	70	29.32	29.99	+ .01	68.6	− 0.2	88	24	76	50	19	62	26				4.98	+ 1.2	12	4,692	e.	26	n.	17	9	9	12	5.3	
Toledo	628	207	246	29.32	30.00	+ .03	68.8	− 0.6	88	28	77	48	18	61	28	63	59	75	4.31	+ 0.9	13	8,063	sw.	43	sw.	27	10	15	5	4.4	
Detroit	730	218	258	29.22	30.01	+ .04	67.1	− 0.7	87	28	75	48	18	59	27	61	57	74	4.95	+ 1.1	13	7,924	sw.	34	e.	8	9	12	9	5.2	

TABLE I.—*Climatological data for U. S. Weather Bureau stations, June, 1909*—Continued.

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.									Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max. + mean min. ÷ 2	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.					
Upper Lake Region.							62.9	+ 0.8										74	2.84	− 0.6										5.2	
Alpena	609	13	92	29.34	30.00	+ .04	62.2	+ 1.9	91	21	73	38	15	51	39	55	50	69	0.91	− 2.6	5	6,231	se.	30	nw.	17	11	11	8	4.9	
Escanaba	612	40	82	29.35	30.00	+ .06	61.2	+ 0.6	86	30	70	38	18	52	32	55	51	70	2.44	− 1.2	7	6,320	s.	25	sw.	16	15	10	5	4.0	
Grand Haven	632	54	92	29.31	29.98	+ .02	63.8	− 0.9	86	29	71	43	18	56	24	60	57	81	5.03	+ 2.5	16	6,320	sw.	28	sw.	16	8	14	8	5.3	
Grand Rapids	707	127	162	29.24	30.00	+ .03	67.1	− 1.0	91	28	76	44	15	58	27	60	56	73	7.50	+ 5.0	15	6,109	e.	29	sw.	13	6	11	13	6.4	
Houghton	668	66	74	29.27	29.99	+ .05	61.2	+ 1.8	93	21	72	35	14	50	38	...	...	...	1.17	− 2.3	7	4,845	w.	22	w.	24	13	14	3	3.9	
Marquette	734	77	116	29.22	30.02	+ .08	59.8	+ 1.3	91	21	69	40	18	51	30	53	47	66	1.65	− 1.9	8	5,204	nw.	30	sw.	20	13	13	4	4.0	
Port Huron	638	70	120	29.31	29.99	+ .02	64.6	+ 0.8	88	30	73	44	18	56	37	59	55	74	1.47	− 1.8	10	6,215	sw.	28	n.	5	6	12	12	6.2	
Sault Sainte Marie	614	40	61	29.32	30.01	+ .05	60.2	+ 2.6	89	21	72	36	15	48	39	53	48	67	0.70	− 2.1	5	5,123	w.	32	nw.	17	9	12	9	5.3	
Chicago	823	140	310	29.12	30.00	+ .04	66.6	+ 0.3	87	22	73	48	15	60	30	61	57	77	5.09	+ 1.4	13	8,006	ne.	48	sw.	22	7	11	12	6.2	
Milwaukee	681	122	139	29.29	30.02	+ .07	63.2	− 0.3	86	23	71	46	8	56	26	58	55	78	2.58	− 1.1	10	6,302	n.	31	ne.	7	10	15	5	4.6	
Green Bay	617	49	86	29.32	29.97	+ .02	66.3	+ 1.2	93	30	76	45	18	57	29	60	56	71	4.16	+ 0.6	9	6,296	sw.	30	n.	17	4	18	8	6.2	
Duluth	1,133	11	47	28.78	30.00	+ .08	59.1	+ 1.4	87	29	70	38	13	48	40	56	54	86	1.33	− 3.2	7	8,852	ne.	37	ne.	13	11	9	10	5.3	
North Dakota.							63.8	+ 0.1										74	3.17	− 0.6										4.6	
Moorhead	940	8	57	28.97	29.98	+ .08	65.2	+ 0.9	92	19	76	41	14	54	37	61	58	78	3.42	− 0.7	15	4,796	ne.	30	ne.	29	15	11	4	3.5	
Bismarck	1,674	8	57	28.22	29.98	+ .11	64.8	+ 0.6	98	28	76	40	14	54	34	59	55	73	2.19	− 1.4	12	7,194	e.	38	w.	21	11	7	12	5.5	
Devils Lake	1,482	11	44	28.40	29.95	+ .07	62.6	0.0	89	28	73	41	14	53	31	57	52	71	3.05	− 0.5	13	7,849	ne.	36	ne.	6	13	13	4	4.4	
Williston	1,872	14	56	27.98	29.93	+ .07	62.4	− 1.1	91	18	72	40	25	52	33	57	53	72	4.02	+ 0.4	12	6,663	e.	35	w.	21	11	10	9	5.2	
Upper Miss. Valley.							70.6	− 0.2										75	3.70	− 0.6										5.8	
Minneapolis	918	102	208	...	...	...	67.4	...	90	29	77	44	14	58	26	...	...	...	2.68	− 1.3	9	7,078	e.	36	nw.	23	11	6	13	5.6	
St. Paul	837	171	179	29.08	29.97	+ .05	66.8	− 0.6	88	29	76	45	14	57	25	60	56	71	4.41	0.0	9	5,553	e.	36	nw.	23	10	14	6	4.9	
La Crosse	714	11	48	29.21	29.97	+ .04	67.9	− 0.3	92	30	78	47	10	58	30	...	...	...	1.99	− 2.4	13	2,829	s.	17	e.	26	11	6	13	5.6	
Madison	974	70	78	28.97	29.99	+ .05	66.6	− 0.7	90	30	76	48	15	58	29	61	58	75	2.78	− 1.3	13	4,994	sw.	25	ne.	7	8	15	7	5.6	
Charles City	1,015	10	49	28.92	29.98	+ .07	67.1	− 1.7	90	30	78	45	15	56	30	62	59	79	5.42	+ 0.3	16	3,909	s.	29	nw.	22	6	10	14	6.4	
Davenport	606	71	79	29.32	29.97	+ .03	70.4	− 0.5	90	30	80	49	15	61	27	64	61	75	2.80	− 1.3	12	4,244	e.	26	w.	23	8	11	11	5.9	
Des Moines	861	84	101	29.06	29.95	+ .03	70.0	− 0.4	88	26	79	54	11	61	29	65	62	79	7.03	+ 2.0	18	4,671	s.	32	ne.	29	6	6	18	7.0	
Dubuque	698	100	115	29.26	30.00	+ .07	68.7	− 0.9	90	30	78	46	15	60	27	62	58	71	6.61	+ 2.1	13	3,703	s.	25	nw.	26	9	9	12	5.8	
Keokuk	614	64	78	29.31	29.97	+ .03	72.8	+ 0.3	90	24	82	50	15	63	29	66	63	76	5.11	+ 0.8	8	3,995	s.	22	nw.	7	11	17	2	4.1	
Cairo	356	87	93	29.61	29.98	+ .01	76.8	+ 1.6	92	28	85	61	4	68	23	69	66	74	1.88	− 2.4	10	4,799	sw.	35	sw.	26	5	17	8	5.6	
La Salle	536	56	64	29.43	30.00	+ .05	69.6	− 0.5	90	29	80	46	19	60	35	...	...	...	2.33	− 1.7	13	4,435	ne.	26	sw.	24	5	11	14	6.7	
Peoria	609	11	45	29.33	29.99	+ .04	71.2	+ 0.3	90	22	81	47	15	61	30	65	62	76	3.56	− 0.7	9	4,252	ne.	30	n.	24	7	17	6	5.6	
Springfield, Ill	644	10	91	29.29	29.97	+ .02	73.0	+ 0.7	92	24	83	51	18	63	31	67	64	77	4.11	− 0.2	11	4,917	s.	39	e.	29	9	7	14	6.0	
Hannibal	534	75	109	29.40	29.96	+ .01	72.8	− 0.5	91	27	82	50	15	64	27	...	...	...	2.15	− 1.4	13	5,326	sw.	26	se.	2	9	16	5	5.2	
St. Louis	567	208	217	29.36	29.96	+ .01	75.0	− 0.1	92	27	83	57	18	67	23	67	63	70	2.63	− 1.8	10	6,059	sw.	42	s.	25	2	15	13	6.8	
Missouri Valley.							70.8	− 0.2										74	4.76	+ 0.4										5.2	
Columbia, Mo	784	11	84	29.15	29.96	+ .01	72.5	− 2.0	91	27	82	53	15	63	29	...	...	...	9.22	+ 4.8	12	4,418	s.	25	nw.	27	9	19	2	4.1	
Kansas City	963	161	181	28.92	29.93	+ .01	73.4	+ 0.4	90	7	82	59	15	65	23	66	63	75	6.01	+ 1.4	10	7,548	s.	49	nw.	9	4	20	6	5.5	
Springfield, Mo	1,324	98	104	28.60	29.98	+ .03	72.2	− 0.1	90	29	81	57	3	64	25	67	64	80	6.70	+ 1.5	16	5,571	s.	32	nw.	22	12	12	6	4.2	
Iola	984	11	50	28.93	29.95	+ .02	74.1	+ 0.7	90	27	83	58	2	65	27	...	...	...	6.41	+ 1.7	18	4,468	s.	27	nw.	22	7	16	7	5.5	
Topeka	983	85	101	...	...	...	73.8	+ 0.3	93	7	83	57	4	64	27	...	...	...	3.54	− 1.2	13	6,131	s.	38	sw.	9	11	16	3	4.3	
Lincoln	1,189	11	84	28.69	29.92	+ .02	71.3	− 0.3	92	26	81	51	15	62	32	64	61	74	3.08	− 1.2	10	6,215	ne.	34	nw.	23	2	16	12	7.0	
Omaha	1,105	115	121	28.78	29.94	+ .03	70.4	− 1.2	91	26	78	56	13	62	26	64	61	76	7.54	+ 2.5	13	5,073	s.	27	nw.	22	3	14	13	6.6	
Valentine	2,598	47	54	27.27	29.95	+ .09	67.2	+ 0.1	98	28	79	44	14	56	35	59	55	71	1.64	− 2.2	12	6,479	e.	40	nw.	5	12	18	0	4.1	
Sioux City	1,135	96	164	28.76	29.95	+ .05	68.5	− 0.9	91	26	78	51	14	59	30	...	...	...	5.20	+ 1.3	15	7,526	s.	48	sw.	20	8	9	13	6.0	
Pierre	1,572	70	75	28.30	29.93	+ .06	6.96	+ 0.7	100	28	80	46	14	59	31	60	55	65	1.39	− 1.7	11	6,904	se.	51	sw.	20	13	10	7	4.8	
Huron	1,306	56	67	28.59	29.97	+ .09	67.2	+ 0.6	90	26	78	39	14	56	32	62	59	77	0.95	− 2.8	10	6,989	se.	37	sw.	20	14	9	7	4.6	
Yankton	1,233	49	57	28.64	29.93	+ .04	69.0	− 0.4	94	5	79	48	14	59	31	...	...	...	5.50	+ 1.2	15	4,635	ne.	29	w.	5	2	23	5	6.0	
Northern Slope.							62.2	+ 0.1										65	3.54	+ 1.2										4.9	
Havre	2,505	11	44	27.34	29.94	+ .09	62.8	+ 0.4	91	30	74	41	10	52	34	55	51	72	3.91	+ 1.1	11	5,402	e.	39	sw.	16	19	8	3	3.9	
Miles City	2,371	26	48	27.44	29.94	+ .09	67.5	+ 1.5	97	18	79	48	13	56	36	60	56	69	2.19	− 0.6	10	4,543	ne.	26	ne.	29	14	10	6	4.1	
Helena	4,110	8	56	25.80	29.94	+ .06	58.7	− 1.9	85	30	69	39	9	48	37	50	44	67	4.30	+ 2.2	13	4,417	sw.	33	w.	21	5	12	13	6.4	
Kalispell	2,962	11	34	26.92	29.93	+ .04	58.9	+ 0.1	88	30	71	40	10	47	38	50	44	63	3.05	+ 1.3	12	3,619	w.	19	sw.	2	11	11	8	5.0	
Rapid City	3,234	46	50	26.60	29.96	+ .11	65.4	+ 1.6	91	19	76	46	14	55	33	58	53	67	7.54	+ 4.0	20	4,713	se.	37	nw.	4	12	13	5	4.5	
Cheyenne	6,088	56	64	24.07	29.93	+ .09	61.3	− 0.2	89	28	74	41	1	48	37	51	45	64	4.01	+ 2.4	15	5,930	s.	43	w.	5	10	14	6	4.8	
Lander	5,372	26	36	24.67	29.92	+ .07	60.9	− 0.4	90	28	78	33	9	44	46	49	39	50	0.64	− 0.5	9	3,049	sw.	26	s.	19	8	18	4	4.7	
Sheridan	3,790	9	47	26.09	29.94	...	61.4	...	95	27	74	40	9	49	47	54	50	68	3.05	...	11	4,372	nw.	44	nw.	4	10	10	10	5.2	
Yellowstone Park	6,200	11	48	23.91	29.93	+ .01	55.0	− 1.0	86	30	68	33	9	42	36	45	37	59	5.75	− 0.9	8	5,154	sw.	27	s.w	21	6	12	12	6.1	
North Platte	2,821	11	51	27.08	29.96	+ .10	69.0	+ 0.6	96	5	80	48	3	58	37	61	58	73	5.46	+ 2.2	12	5,196	se.	34	ne.	9	17	7	6	4.0	T.
Middle Slope.							72.2	+ 0.5										67	3.00	− 0.2										4.7	
Denver	5,291	129	136	24.76	29.93	+ .09	65.7	− 0.7	92	27	78	46	3	53	37	54	47	59	1.70	+ 0.2	13	4,697	sw.	31	se.	17	14	12	4	4.4	
Leadville	10,242	7																													
Pueblo	4,685	80	86	25.30	29.90	+ .07	69.8	+ 1.8	96	27	84	46	3	56	42	55	48	56	1.78	+ 0.3	10	4,772	se.	37	ne.	13	15	11	4	3.6	
Concordia	1,398	42	50	28.49	29.93	+ .03	72.8	+ 0.1	94	27	83	53	3	63	31	66	63	75	3.18	− 1.8	16	4,618	s.	34	nw.	8	2	24	4	6.0	
Dodge City	2,509	44	54	27.34	29.88	+ .01	73.7	+ 0.6	99	6	85	51	3	62	35	64	60	68	3.20	− 0.1	12	7,139	se.	42	nw.	21	14	13	3	4.2	
Wichita	1,358	98	121	28.55	29.95	+ .04	74.4	+ 0.1	94	29	84	54	3	64	28	67	64	72	5.71	+ 1.0	14	6,690	s.	45	ne.	7	4	24	2	5.3	
Oklahoma	1,214	10	47	28.68	29.92	+ .01	76.6	+ 0.9	98	17	87	57	3	67	28	68	64	70	2.44	− 0.6	10	8,743	s.	50	n.	29	8	19	3	4.8	
Southern Slope.							78.2	+ 1.1										58	2.66	− 0.2										4.4	
Abilene	1,738	45	54	28.14	29.90	+ .02	79.5	+ 1.3	96	9	91	60	2	68	31	68	61	60	4.04	+ 0.9	10	5,093	se.	33	nw.	11	14	12	4	4.5	
Amarillo	3,676	10	49	26.26	29.90	+ .05	73.5	+ 1.5	99	6	87	52	3	60	37	62	56	63	4.72	+ 1.7	14	9,003	s.	48	e.	20	13	15	2	4.2	
Del Rio	944	8	57	28.90	29.86	+ .01	84.0	+ 1.9	102	4	95	60	2	73	34	...	...	...	0.81	− 2.3	5	7,110	se.	37	se.	12	15	11	4	4.1	
Roswell	3,578	9	57	26.31	29.86	+ .06	76.0	− 0.3	96	21	92	50	10	60	45	60	51	52	1.05	− 1.0	5	4,479	s.	34	ne.	28	9	17	4	4.7	
Southern Plateau.							74.5	− 0.1										32	0.07	− 0.3										1.6	
El Paso	3,762	110	133	26.11	29.74	− .01	81.0	+ 1.4	98	21	94	55	1	68	33	58	38	29	0.05	− 0.5	2	7,496	se.	54	ne.	25	22	8	0	2.2	
Santa Fe	7,013	8	56	23.31	29.80	− .01	65.8	− 0.4	86	30	79	40	2	52	34	49	33	33	0.20	− 0.8	5	6,630	sw.	44	e.	29	18	12	0	3.0	
Flagstaff	6,907	8	57	23.39	29.82	+ .04	58.8	− 0.5	89	30	78	31	8	39	46	42	27	37	0.22	− 0.3	2	6,202	sw.	36	sw.	7	26	4	0	1.3	
Phoenix	1,108	50	56	28.63	29.74	.00	84.8	+ 0.4	109	30	101	61	10	69	37	60	39	23	T.	− 0.1	0	3,199	e.	20	w.	7	25	5	0	1.3	
Yuma	141	9	58	29.59	29.73	− .01	83.8	− 0.9	111	30	102	58	9	65	45	64	53	42	0.00	0.0	0	4,610	sw.	23	se.	25	29	1	0	0.3	
Brawley	†105	11	31	29.84	29.73	...	84.6	...	112	30	103	60	9	66	44	...	...	...	0.00	0.0	0	4,870	se.	27	sw.	6	26	3	1	1.0	
Independence	3,910	11	42	25.90	29.80	+ .02	73.0	− 0.4	99	24	88	45	19	57	38	53	34	27	T.	− .01	0	5,873	nw.	36	se.	17	24	4	2	2.3	
Middle Plateau.							66.8	+ 2.4										35	0.14	− 0.4										2.8	
Reno	4,532	56	63	25.44	29.87	+ .01	63.6	+ 2.6	90	2	79	40	8	48	42	48	37	45	0.25	0.0	2	4,545	w.	24	w.	13	24	2	4	2.2	
Tonopah	6,090	12	20	24.04	29.77	...	67.8	+ 7.6	91	24	80	40	19	55	30	47	28	27	0.15	− 0.3	2	6,625	w.	42	se.	18	15	14	1	2.8	
Winnemucca	4,344	18	56	25.57	29.89	+ .01	65.0	+ 1.7	95	30	83	33	8	47	48	49	36	45	0.03	− 0.6	1	4,219	sw.	41	nw.	7	21	6	3	2.7	
Modena	5,479	10	43	24.59	29.82	.00	65.4	+ 2.2	94	30	83	40	11	48	46	46	24	26	T.	− 0.4	0	9,315	sw.	60	sw,	18	20	9	1	2.7	
Salt Lake City	4,360	105	110	25.56	29.85	.00	69.9	+ 1.6	95	30	82	44	10	58	33	52	39	36	0.17	− 0.6	4	4.443	se.	33	w.	7	19	9	2	2.9	
Durango	6,546	18	56	23.69	29.84	+ .02	63.4	+ 0.7	94	30	82	38	9	45	43	46	31	38	0.27	− 0.5	3	4,523	nw.	29	sw.	18	17	13	0	3.1	
Grand Junction	4,608	43	51	25.34	29.85	+ .02	72 7	+ 0.1	98	30	88	47	2	57	37	52	35	30	0.10	− 0.2	2	4,249	e.	28	se.	6	20	10	0	3.2	
Northern Plateau.							64.4	− 0.5										61	0.86	− 0.3										4.2	
Baker City	3,471	48	58	26.43	29.97	+ .02	59.8	+ 1.2	92	30	72	38	6	48	41	52	46	64	1.66	+ 0.4	6	4,196	nw.	24	s.	29	8	19	3	4.4	
Boise	2,739	78	86	27.10	29.92	+ .01	66.4	+ 0.4	97	29	80	41	8	53	42	52	41	46	0.78	− 0.1	4	3,901	nw.	27	nw.	15	14	13	3	3.7	
Lewiston	757	10	51	29.16	29.96	+ .02	66.8	− 2.3	97	1	79	45	6	54	40	...	...	...	0.48	− 0.6	6	4,195	e.	46	w.	1	7	11	12	5.9	
Pocatello	4,477	46	54	25.45	29.90	+ .03	64.4	+ 0.2	94	30	78	40	10	51	35	50	40	47	0.49	− 0.5	4	5,486	se.	30	sw.	16	11	16	3	4.1	
Spokane	1,929	101	110	27.94	29.97	+ .03	62.4	− 1.0	92	1	74	46	25	51	37	51	41	52	1.03	− 0.6	10	4,170	s.	32	s.	1	6	15	9	5.9	
Walla Walla	1,000	71	79	28.92	29.98	+ .02	66.6	− 1.6	96	1	78	47	6	55	35	53	41	45	0.69	− 0.5	7	4,143	s.	32	se.	18	13	9	8	4.6	
N. Pac. Coast Reg.							57.1	− 0.4										71	0.96	− 1.1										6.0	
Blaine	58	4	...	...	...	...	...	...	80	10	...	37	13	...	...	...	...	...	1.41	...	...	...	...	...	...	...	...	...	...	...	
North Head	211	11	56	29.87	30.10	+ .11	53.1	− 1.9	62	10	56	47	13	50	14	51	49	87	1.33	− 0.4	10	12,369	nw.	64	se.	27	12	5	13	5.8	

TABLE I.—*Climatological data for U. S. Weather Bureau stations, June, 1909*—Continued.

Stations.	Elevation of instruments. Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Pressure, in inches. Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Temperature of the air, in degrees Fahrenheit. Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches. Total.	Departure from normal.	Days with .01, or more.	Wind. Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.
N.P.Coast Reg.-Con.																															
Port Crescent	259	8	53	29.83	30.12	+ .09	51.2	− 2.2	72	10	60	35	25	43	30				0.92	− 0.9	9	3,814	nw.	17	nw.	29	10	15	5	4.9	
Seattle	123	185	224	29.95	30.08	+ .08	59.4	− 0.7	83	10	68	46	5	51	31	52	46	65	0.64	− 1.1	7	5,385	s.	29	s.	23	9	7	14	5.8	
Tacoma	213	113	120	29.82	30.05	+ .02	59.6	+ 0.2	85	10	69	45	13	50	34	52	46	65	0.60	− 1.5	6	4,373	n.	20	sw.	23	13	8	9	4.7	
Tatoosh Island	86	7	57	29.99	30.09	+ .07	52.1	− 0.9	65	7	56	45	13	48	19	49	47	85	2.36	− 1.8	13	7,025	sw.	46	s.	11	9	6	15	6.0	
Portland, Oreg	153	68	106	29.90	30.06	+ .02	62.7	+ 1.4	90	10	73	43	13	52	36	54	47	62	0.17	− 1.6	5	4,559	nw.	25	s.	27	12	11	7	4.5	
Roseburg	510	9	57	29.50	30.05	+ .02	61.9	+ 1.0	92	10	76	41	5	48	42	52	43	62	0.70	− 0.4	4	2,990	nw.	18	nw.	6	13	16	1	3.3	
Mid. Pac. Coast Reg.							**62.9**	**− 1.4**										**64**	**0.08**	**− 0.2**										**3.5**	
Eureka	62	62	80	30.01	30.08	+ .03	53.0	− 1.6	66	14	57	44	7	49	20	50	48	87	0.14	− 0.9	2	5,864	nw.	40	nw.	23	7	16	7	5.3	
Mount Tamalpais	2,375	11	18	27.51	29.96	+ .01	61.3		92	23	70	40	13	53	29	51	42	53	T.	− 0.2	0	12,509	nw.	80	nw.	14	25	2	3	1.8	
Point Reyes Light	490	7	18	29.42	29.94		51.2		61	24	55	45	6	47	13				T.		0	22,774	nw.	76	nw.	25	8	11	11	5.9	
Red Bluff	332	50	56	29.53	29.87	− .01	75.7	0.0	101	24	88	55	18	63	83	58	44	39	0.31	− 0.2	2	4,427	se.	23	s.	5	25	1	4	2.0	
Sacramento	69	106	117	29.82	29.89	.00	68.2	− 0.7	98	22	82	50	14	55	36	57	50	58	0.03	− 0.1	1	6,659	s.	30	sw.	26	25	2	3	1.6	
San Francisco	155	200	204	29.80	29.97	+ .01	56.1	− 0.9	94	23	62	47	3	50	31	51	48	81	T.	− 0.2	0	8,769	w.	36	sw.	24	16	9	5	3.6	
San José	141	12	110	29.83	29.98		61.4	− 3.6	100	23	74	42	14	48	45				0.05	0.0	1	4,666	nw.	24	se.	7	23	5	2	2.3	
Southeast Farallon	30	9	17	29.97	30.00		51.7		57	8	54	48	9	50	7				0.06	− 0.1	1	14,363	nw.	46	nw.	11	10	10	10	5.2	
S. Pac. Coast Reg.							**65.5**	**− 0.6**										**66**	**0.05**	**0.0**										**3.6**	
Fresno	330	67	70	29.53	29.88	+ .03	74.9	− 0.9	106	24	92	50	14	58	41	56	41	36	0.08	0.0	1	4,568	nw.	20	nw.	16	27	1	2	1.4	
Los Angeles	338	159	191	29.56	29.92	+ .02	65.6	+ 1.1	95	1	74	52	17	57	30	58	54	74	0.11	0.0	1	4,090	sw.	21	sw.	17	12	16	2	3.8	
San Diego	87	94	102	29.83	29.92	.00	62.6	− 1.2	77	2	67	53	20	58	16	58	55	79	T.	0.0	0	4,352	sw.	20	nw.	17	9	12	9	5.3	
San Luis Obispo	201	47	54	29.76	29.98	+ .03	59.0	− 1.4	87	2	70	41	14	48	36	52	48	73	T.	− 0.1	0	4,044	nw.	22	nw.	15	12	16	2	3.7	
West Indies.																															
Grand Turk	11	6	20	30.02	30.03	+ .02	81.8		90	14	88	68	23	76					2.26		12										
San Juan	82	48	90	29.93	30.02	+ .03	79.0		88	1	85	66	19	73	16	74	72	78	8.86	+ 4.0	19	8,851	e.	42	se.	20	8	14	8	5.5	
Panama.																															
Christobal	17	5	60	29.84	29.86		78.7		92	3	84	70	17	73	17	76	75	91	17.49		23	4,082	se.	33	se.	1	1	24	5	6.0	
Culebra	172	4	30	29.45	29.86		78.4		91	12	85	68	5	71	22	74	73	94	9.44		25	3,484	nw.	25	ne.	5	1	11	18	8.0	
Ancon	92	6	69	29.76	29.85		78.8		89	25	85	70	5	73	17	75	74	92	9.90		25	4,089	nw.	24	s.	21	0	8	22	8.0	
Alhajuela																			19.73		26										
Bohio																			12.31		25										
Gatun																			16.35		27										

† Below sea level.

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, for storms in which the rate of fall equaled or exceeded 0.25 in any 5 minutes, or 0.80 inch in 1 hour, during June, 1909, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration. From—	To—	Total amount of precipitation.	Excessive rate. Began—	Ended—	Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated. 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex	11	12:10 a. m.	1:05 a. m.	0.82	12:17 a. m.	12:35 a. m.	0.02	0.10	0.35	0.68	0.77										
Albany, N. Y	17			0.88														0.26			
Alpena, Mich	17			0.62														0.31			
Amarillo, Tex	13-14	11:16 p. m.	12:10 a. m.	0.84	11:21 p. m.	11:43 p. m.	0.02	0.14	0.52	0.67	0.79	0.81									
Anniston, Ala	10	1:10 p. m.	4:30 p. m.	1.26	3:38 p. m.	4:07 p. m.	0.62	0.31	0.37	0.38	0.40	0.50	0.63								
Asheville, N. C	12	1:20 p. m.	3:50 p. m.	1.01	1:37 p. m.	2:02 p. m.	0.01	0.10	0.26	0.40	0.59	0.66									
Atlanta, Ga	24	4:10 p. m.	5:35 p. m.	0.79	4:32 p. m.	4:54 p. m.	0.01	0.19	0.40	0.55	0.69	0.73									
Atlantic City, N. J	9			1.02														0.34			
Augusta, Ga	22	12:57 p. m.	5:25 p. m.	1.37	1:20 p. m.	2:10 p. m.	0.15	0.09	0.18	0.48	0.57	0.60	0.69	0.80	0.92	0.98	1.05				
Baker City, Oreg	18	2:05 p. m.	2:55 p. m.	0.46	2:19 p. m.	2:37 p. m.	0.01	0.15	0.25	0.37	0.42										
Baltimore, Md	5	1:50 p. m.	9:00 p. m.	0.58	5:21 p. m.	5:30 p. m.	0.11	0.32	0.40												
Bentonville, Ark	2	1:10 p. m.	2:05 p. m.	0.75	1:16 p. m.	1:33 p. m.	0.02	0.28	0.50	0.66	0.69										
Do	30	12:35 p. m.	3:40 p. m.	1.22	1:13 p. m.	1:38 p. m.	0.02	0.16	0.46	0.78	0.95	1.04									
Binghamton, N. Y	10			1.39														0.53			
Birmingham, Ala	22	1:22 p. m.	3:50 p. m.	0.80	2:00 p. m.	2:30 p. m.	0.01	0.15	0.25	0.27	0.35	0.52	0.65								
Bismarck, N. Dak	30			0.71														0.24			
Block Island, R. I	23			0.15														0.15			
Boise, Idaho	19			0.42														0.36			
Boston, Mass	5			2.43														0.55			
Buffalo, N. Y	10			0.49														0.20			
Burlington, Vt	17-18	4:20 p. m.	D. N.	1.96	4:29 p. m.	5:07 p. m.	0.01	0.25	0.34	0.47	0.64	0.73	0.86	0.91							
Cairo, Ill	29	2:43 p. m.	3:25 p. m.	0.32	2:43 p. m.	2:50 p. m.	0.00	0.21	0.30												
Canton, N. Y	5			0.67														0.45			
Charles City, Iowa	26	3:30 p. m.	5:05 p. m.	1.06	3:38 p. m.	4:05 p. m.	0.01	0.08	0.31	0.66	0.86	0.94	0.98								
Charleston, S. C	19			0.48														0.30			
Charlotte, N. C	3-4	D. N.	D. N.	3.86	3:46 p. m.	4:29 p. m.	1.47	0.05	0.11	0.21	0.34	0.39	0.49	0.67	0.98	1.06					
Do	12-13	7:10 p. m.	D. N.	1.43	7:14 p. m.	7:39 p. m.	0.02	0.17	0.39	0.56	0.66	0.77									
Chattanooga, Tenn	14	9:38 a. m.	10:40 a. m.	0.48	9:56 a. m.	10:11 a. m.	0.01	0.13	0.31	0.46											
Cheyenne, Wyo	7	7:18 p. m.	D. N.	0.77	9:01 p. m.	9:11 p. m.	0.05	0.30	0.60												
Chicago, Ill	22	6:23 p. m.	7:02 p. m.	0.80	6:24 p. m.	6:39 p. m.	0.01	0.48	0.68	0.75											
Cincinnati, Ohio	10	5:10 p. m.	6:18 p. m.	0.72	5:23 p. m.	5:35 p. m.	0.04	0.30	0.62	0.63											
Cleveland, Ohio	17			0.94														0.57			
Columbia, Mo	16-17	8:11 p. m.	D. N.	1.11	10:50 p. m.	11:35 p. m.	0.10	0.11	0.15	0.37	0.69	0.74	0.77	0.89	0.94	1.01					
Do	27	5:38 p. m.	9:51 p. m.	2.58	7:05 p. m.	8:28 p. m.	1.02	0.23	0.44	0.44	0.44	0.58	0.67	0.67	0.67	0.67	0.68	0.89	1.45	1.51	
Do	29	3:39 p. m.	5:34 p. m.	2.86	3:43 p. m.	4:48 p. m.	0.01	0.14	0.43	0.79	1.01	1.24	1.44	1.77	1.88	2.02	2.30	2.73	2.84		
Columbia, S. C	16	5:00 p. m.	7:30 p. m.	0.91	6:21 p. m.	6:40 p. m.	0.08	0.08	0.51	0.71	0.81										
Do	26-27	8:35 p. m.	D. N.	2.15	9:35 p. m.	10:40 p. m.	0.07	0.07	0.17	0.26	0.47	0.61	0.77	0.95	1.13	1.35	1.54	1.71	1.88		
Columbus, Ohio	8	8:14 p. m.	D. N.	0.67	8:18 p. m.	8:38 p. m.	0.01	0.12	0.29	0.43	0.51										
Concord, N. H	5			1.07														0.64			
Concordia, Kans	8			0.82														0.51			
Corpus Christi, Tex	12			0.25														0.22			
Davenport, Iowa	24	D. N.	6:57 a. m.	0.92	5:04 a. m.	5:24 a. m.	0.02	0.24	0.54	0.73	0.85										
Del Rio, Tex	23			0.56														0.53			
Denver, Colo	1			0.49														0.16			
Des Moines, Iowa	23	5:10 p. m.	5:38 p. m.	0.69	5:15 p. m.	5:31 p. m.	0.01	0.15	0.48	0.63	0.66										
Do	29	4:02 p. m.	5:10 p. m.	0.72	4:33 p. m.	4:47 p. m.	0.12	0.28	0.54	0.60											
Detroit, Mich	26	D. N.	D. N.	2.10	1:23 a. m.	3:03 a. m.	0.01	0.19	0.37	0.49	0.52	0.53	0.59	0.66	0.74	0.78	0.90	1.08	1.50	1.95	
Do	27	2:25 p. m.	3:10 p. m.	0.66	2:41 p. m.	3:01 p. m.	0.02	0.06	0.25	0.47	0.64										
Devils Lake, N. Dak	20	8:30 a. m.	9:40 a. m.	0.54	8:37 a. m.	8:51 a. m.	0.02	0.12	0.40	0.45											
Dodge City, Kans	11	D. N.	7:10 a. m.	1.41	4:22 a. m.	4:50 a. m.	T.	0.08	0.26	0.46	0.64	0.78	0.82								
Dubuque, Iowa	22	1:28 p. m.	2:02 p. m.	0.90	1:39 p. m.	2:00 p. m.	0.05	0.08	0.21	0.50	0.84	0.85									

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, etc.*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Dubuque, Iowa	24	12:30 a. m.	D. N.	1.54	12:44 a. m.	:44 a. m.	0.05	0.26	0.42	0.56	0.72	0.90	1.04	1.13	1.20	1.28	1.35	1.46			
Duluth, Minn.	16			0.75														0.39			
Durango, Colo.	6			0.22														0.17			
Eastport, Me.	18			0.80														0.48			
Elkins, W. Va.	1	2:25 p. m.	3:40 p. m.	1.19	2:32 p. m.	2:42 p. m.	0.01	0.40	0.69												
Do.	27–28	7:40 p. m.	12:45 a. m.	1.18	8:58 p. m.	9:18 p. m.	0.36	0.16	0.36	0.47	0.55										
El Paso, Tex.	15			0.04														0.04			
Erie, Pa.	10			0.79														0.43			
Escanaba, Mich.	1			0.71														0.25			
Eureka, Cal.	15			0.12														0.04			
Evansville, Ind.	12	9:40 p. m.	D. N.	0.86	10:01 p. m.	10:27 p. m.	0.02	0.21	0.27	0.35	0.53	0.61	0.66								
Flagstaff, Ariz.	29			0.17														0.17			
Fort Smith, Ark.	11	1:46 p. m.	3:14 p. m.	0.75	1.54 p. m.	2:14 p. m.	0.01	0.08	0.20	0.44	0.66										
Fort Worth, Tex.	18	1:40 p. m.	3:45 p. m.	1.84	2:05 p. m.	2:40 p. m.	0.02	0.41	0.75	1.12	1.41	1.61	1.72	1.80							
Fresno, Cal.	17			0.08														0.03			
Galveston, Tex.	13	7:50 p. m.	9:05 p. m.	1.09	8:36 p. m.	9:03 p. m.	0.04	0.06	0.27	0.61	0.90	1.03	1.05								
Do.	14	4:22 p. m.	5:04 p. m.	0.74	4:25 p. m.	4:47 p. m.	T.	0.29	0.39	0.42	0.72	0.74									
Grand Haven, Mich.	22			1.28														0.64			
Grand Junction, Colo.	9			0.07														*			
Grand Rapids, Mich.	26	7:35 p. m.	9:50 p. m.	2.78	8:37 p. m.	9:25 p. m.	0.57	0.36	0.84	1.10	1.31	1.51	1.71	1.86	2.01	2.11	2.19				
Green Bay, Wis.	13	9:15 a. m.	9:55 a m.	0.82	9:17 a. m.	9:37 a. m.	0.01	0.33	0.64	0.67	0.79										
Greenville, Me.	17–18			2.03														*			
Hannibal, Mo.	26	4:56 p. m.	5:35 p. m.	0.57	4:59 p. m.	5:16 p. m.	0.01	0.12	0.31	0.46	0.51										
Harrisburg, Pa.	25	1:20 p. m.	2:05 p. m.	0.59	1:30 p. m.	1:55 p. m.	0.01	0.08	0.23	0.30	0.45	0.57									
Hartford, Conn.	17–18			0.77														0.35			
Hatteras, N. C.	5	9:40 p. m.	10:55 p. m.	1.88	9:41 p. m.	10:33 p. m.	0.01	0.21	0.40	0.62	1.00	1.16	1.20	1.25	1.39	1.58	1.83	1.86			
Havre, Mont.	16			0.36														0.36			
Helena, Mont.	29	4:06 p. m.	7:45 p. m.	0.94	4:50 p. m.	5:12 p. m.	0.08	0.08	0.18	0.65	0.76	0.81									
Houghton, Mich.	26			0.31														0.26			
Huron, S. Dak.	23			0.40														*			
Independence, Cal.	6, 18			T.														T.			
Indianapolis, Ind.	12–13	3:45 p. m.	D. N.	1.06	4:29 p. m.	4:53 p. m.	0.24	0.07	0.19	0.35	0.45	0.51									
Iola, Kans.	1	6:14 p. m.	8:45 p. m.	1.93	7:35 p. m.	8:16 p. m.	0.32	0.10	0.19	0.58	0.81	1.06	1.33	1.36	1.51	1.56					
Jacksonville, Fla.	18	6:10 p. m.	D. N.	2.48	6:16 p. m.	7:36 p. m.	0.01	0.16	0.22	0.23	0.35	0.50	0.62	0.79	0.97	1.09	1.23	1.68	2.24		
Do.	22	10:01 a. m.	10:35 a. m.	1.14	10:02 a. m.	10:17 a. m.	0.01	0.38	0.90	1.11											
Jupiter, Fla.	9	8:10 a. m.	9:03 a. m.	0.43	8:42 a. m.	8:58 a. m.	0.02	0.11	0.24	0.38	0.40										
Kalispell, Mont.	20			1.24														0.30			
Kansas City, Mo.	9	1:30 a. m.	7:25 a. m.	1.67	4:25 a. m.	5:10 a. m.	0.56	0.21	0.24	0.25	0.34	0.35	0.45	0.60	0.77	0.95					
Do.	27	5:40 p. m.	6:50 p. m.	1.18	5:43 p. m.	6:15 p. m.	0.01	0.13	0.19	0.26	0.52	0.74	0.95	1.00							
Keokuk, Iowa	7	9:10 p. m.	11:55 p. m.	2.50	9:14 p. m.	11:20 p. m.	0.01	0.06	0.16	0.36	0.55	0.74	0.85	0.92	1.07	1.16					
Do.	9	4:30 a. m.	8:30 a. m.	1.20	6:09 a. m.	6:52 a. m.	0.13	0.08	0.12	0.23	0.47	0.52	0.56	0.75	0.88	0.93					
Key West, Fla.	28–29	7:32 p. m.	6:50 a. m.	3.90	7:34 p. m.	8:19 p. m.	0.02	0.25	0.59	0.95	1.16	1.36	1.50	1.62	1.71	1.82					
					10:18 p. m.	11:53 p. m.	1.97	0.31	0.50	0.54	0.61	0.67	0.72	0.75	0.79	0.86	0.88	0.97	1.27	1.59	
Knoxville, Tenn.	30	1:20 p. m.	3:50 p. m.	0.82	1:26 p. m.	1:51 p. m.	0.01	0.16	0.30	0.48	0.63	0.68									
La Crosse, Wis.	9			0.44														0.29			
Lander, Wyo.	7			0.22														0.17			
La Salle, Ill.	8			0.72														0.36			
Lewiston, Idaho	7			0.25														0.18			
Lexington, Ky.	14	2:45 p. m.	3:28 p. m.	0.61	2:51 p. m.	3:09 p. m.	0.01	0.15	0.34	0.48	0.54										
Lincoln, Nebr.	8–9	11:22 p. m.	2:15 a. m.	0.80	12:22 a. m.	12:32 a. m.	0.07	0.29	0.49												
Little Rock, Ark.	20	3:27 p. m.	3:55 p. m.	0.41	3:33 p. m.	3:45 p. m.	0.03	0.11	0.30	0.35											
Los Angeles, Cal.	18			0.11														0.6			
Louisville, Ky.	25–26			0.78														*			
Lynchburg, Va.	11	5:05 p. m.	5:45 p. m.	0.53	5:08 p. m.	5:30 p. m.	0.01	0.19	0.31	0.40	0.49				0.52						
Macon, Ga.	13			0.29														0.27			
Madison, Wis.	25			0.83														0.53			
Marquette, Mich.	16			0.86														0.34			
Memphis, Tenn.	22	3:08 p. m.	3:50 p. m.	0.48	3:13 p. m.	3:25 p. m.	0.01	0.24	0.40	0.46											
Meridian, Miss.	20–21	11:30 a. m.	D. N.	1.98	12:30 a. m.	1:12 a. m.	0.95	0.08	0.19	0.38	0.50	0.51	0.56	0.66	0.76	0.81					
Do.	22	12:56 p. m.	2:15 p. m.	1.45	12:59 p. m.	1:39 p. m.	0.02	0.19	0.34	0.51	0.70	0.86	0.99	1.11	1.30						
Milwaukee, Wis.	22	6:40 p. m.	7:05 p. m.	0.47	6:44 p. m.	6:54 p. m.	0.01	0.32	0.45												
Minneapolis, Minn.	6			0.51														0.45			
Mobile, Ala.	4	1:25 p. m.	2:45 p. m.	0.95	1:37 p. m.	2:31 p. m.	0.02	0.10	0.19	0.24	0.27	0.39	0.46	0.57	0.74	0.78	0.87	0.92			
Do.	20	7:35 a. m.	3:05 p. m.	2.76	7:50 a. m.	9:20 a. m.	0.01	0.07	0.09	0.12	0.19	0.32	0.51	0.67	0.90	0.93	0.95	1.02	1.38	1.78	
Do.	29	1:58 p. m.	3:20 p. m.	0.92	2:03 p. m.	2:30 p. m.	0.01	0.26	0.50	0.67	0.76	0.83	0.88								
Modena, Utah	24			T.														T.			
Montgomery, Ala.	4	3:40 p. m.	4:36 p. m.	0.65	3:42 p. m.	3:58 p. m.	0.01	0.15	0.36	0.53	0.56										
Do.	20–21	8:50 a. m.	7:50 a. m.	1.48	7:03 p. m.	7:21 p. m.	0.57	0.07	0.21	0.40	0.55										
Moorhead, Minn.	15–16	10:50 p. m.	6:35 a. m.	1.50	2:05 a. m.	2:30 a. m.	0.43	0.12	0.28	0.38	0.48	0.54									
Do.	22	1:15 p. m.	2:05 p. m.	0.50	1:17 p. m.	1:34 p. m.	0.01	0.11	0.33	0.44	0.46										
Mount Tamalpais, Cal.	17			T.														0.35			
Mount Weather, Va.	17	2:55 p. m.	7:30 p. m.	1.01	4:00 p. m.	4:31 p. m.	0.14	0.09	0.11	0.14	0.44	0.60	0.68	0.70							
Do.	26–27	8:46 p. m.	D. N.	1.06	10:16 p. m.	10:36 p. m.	0.04	0.34	0.60	0.79	0.88										
Nantucket, Mass.	28			0.75														0.35			
Nashville, Tenn.	12	3:19 p. m.	3:55 p. m.	1.00	3:19 p. m.	3:45 p. m.	0.00	0.22	0.53	0.72	0.88	0.98	0.99								
		6:50 p. m.	8:18 p. m.	0.98	7:31 p. m.	8:10 p. m.	0.04	0.23	0.45	0.55	0.59	0.63	0.66	0.80	0.93						
New Haven, Conn.	28	1:27 p. m.	2:30 p. m.	1.57	1:34 p. m.	2:19 p. m.	0.01			0.57	0.68	0.92	1.31	1.36	1.47	1.56					
New Orleans, La.	2	D. N.	6:10 a. m.	2.07	2:52 a. m.	3:35 a. m.	0.58	0.08	0.21	0.35	0.47	0.65	0.79	0.95	1.18	1.22					
New York, N. Y.	27			0.58														0.42			
Norfolk, Va.	10–11	4:45 p. m.	1:45 a. m.	1.35	7:39 p. m.	7:59 p. m.	0.56	0.13	0.27	0.40	0.50										
Northfield, Vt.	5			1.14														0.24			
North Head, Wash.	1			0.30														0.10			
North Platte, Nebr.	9	8:50 p. m.	11:50 p. m.	2.12	9:14 p. m.	10:39 p. m.	0.04	0.16	0.31	0.48	0.58	0.73	0.92	1.01	1.03	1.06	1.10	1.15	1.77	2.00	
Oklahoma, Okla.	24	7:15 a. m.	3:40 p. m.	1.15	7:40 a. m.	8:15 a. m.	0.09	0.12	0.19	0.24	0.27	0.31	0.38	0.56							
Omaha, Nebr.	28	3:10 a. m.	6:20 a. m.	0.82	4:17 a. m.	4:41 a. m.	0.03	0.09	0.35	0.63	0.69	0.74									
Oswego, N. Y.	5			1.34														0.38			
Palestine, Tex.	30	2:20 p. m.	3:28 p. m.	2.00	2:23 p. m.	3:02 p. m.	0.01	0.39	0.66	1.24	1.56	1.78	1.86	1.91	1.97						
Parkersburg, W. Va.	5			1.06														0.74			
Pensacola, Fla.	2	2:20 p. m.	7:55 p. m.	1.34	3.38 p. m.	3:54 p. m.	0.43	0.06	0.26	0.39	0.43										
Peoria, Ill.	24	6:04 p. m.	7:40 p. m.	1.23	6:16 p. m.	7:03 p. m.	0.06	0.16	0.30	0.34	0.40	0.60	0.74	0.85	0.94	1.06	1.14				
Philadelphia, Pa.	14			0.28														0.25			
Phoenix, Ariz.	28			T.														T.			
Pierre, S. Dak.	8			0.46														0.28			
Pittsburg, Pa.	4	5:30 p. m.	6:45 p. m.	1.25	6:00 p. m.	6:24 p. m.	0.07	0.15	0.31	0.55	1.10	1.17									
Pocatello, Idaho	8			0.26														0.22			
Point Reyes Light, Cal.	17–18			T.														T.			
Port Huron, Mich.	4			0.34														0.30			
Portland, Me.	17–18	11:28 p. m.	6:04 a. m.	1.27	2:14 a. m.	2:41 a. m.	0.31	0.10	0.26	0.36	0.43	0.46	0.48	0.51							
Portland, Oreg.	26			0.07														0.04			
Providence, R. I.	14			0.31														0.30			
Pueblo, Colo.	7	4:26 p. m.	5:50 p. m.	0.48	5:17 p. m.	5:34 p. m.	0.02	0.15	0.29	0.45											
Raleigh, N. C.	17	9:45 p. m.	11:45 p. m.	1.81	9:52 p. m.	10:35 p. m.	0.01	0.07	0.17	0.34	0.52	0.66	1.08	1.32	1.66	1.72					
Rapid City, S. Dak.	10			3.07														0.76			

TABLE II.—*Accumulated amounts of precipitation for each 5 minutes, etc.*—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Red Bluff, Cal.	15			0.28														0.28			
Reno, Nev.	18			0.24														0.11			
Richmond, Va.	17	6:24 p. m.	7:06 p. m.	0.38	6:39 p. m.	6:46 p. m.	0.04	0.27	0.33												
Rochester, N. Y.	5			0.37														0.14			
Roseburg, Oreg.	15			0.52														0.32			
Roswell, N. Mex	28			0.50														0.50			
Sacramento, Cal.	17			0.03														0.01			
St. Louis, Mo.	4	2:10 p. m.	3:00 p. m.	0.49	2:13 p. m.	2:24 p. m.	0.01	0.35	0.47	0.49											
St. Paul, Minn.	22	12:40 p. m.	1:46 p. m.	0.98	12:55 p. m.	1:35 p. m.	0.08	0.08	0.20	0.27	0.35	0.50	0.61	0.80	0.87						
Salt Lake City, Utah	7			0.12														0.10			
San Antonio, Tex.	22	1:05 p. m.	2:40 p. m.	0.91	1:27 p. m.	1:47 p. m.	0.14	0.22	0.48	0.64	0.73										
San Diego, Cal.	4-18			T.														T.			
Sand Key, Fla.	28-29	9:40 p. m.	1:00 a. m.	1.67	10:04 p. m.	11:09 p. m.	0.01	0.06	0.12	0.31	0.49	0.61	0.65	0.76	0.83	0.97	1.25	1.49	1.63		
Sandusky, Ohio	1	12:21 p. m.	12:51 p. m.	0.69	12:23 p. m.	12:42 p. m.	0.02	0.07	0.17	0.51	0.66										
Do.	4	1:42 p. m.	2:27 p. m.	0.73	1:45 p. m.	2:24 p. m.	0.01	0.10	0.20	0.30	0.42	0.51	0.60	0.67	0.72						
San Francisco, Cal.	†			T.														T.			
San José, Cal.	17			0.05														0.02			
San Luis Obispo, Cal.	17			T.														T.			
Santa Fe, N. Mex.	18			0.06														0.05			
Sault Ste. Marie, Mich.	23			0.33														0.23			
Savannah, Ga.	15	1:47 p. m.	3:16 p. m.	0.73	1:57 p. m.	2:07 p. m.	0.01	0.18	0.36												
Scranton, Pa.	25	11:00 a. m.	11:45 a. m.	0.91	11:20 a. m.	11:35 a. m.	0.04	0.34	0.58	0.86											
Seattle, Wash.	25-26			0.29														*			
Sheridan, Wyo.	1	3:16 p. m.	3:46 p. m.	0.45	3:18 p. m.	3:28 p. m.	0.01	0.25	0.40												
Shreveport, La.	11	6:35 p. m.	9:00 p. m.	0.81	6:46 p. m.	7:23 p. m.	0.02	0.07	0.25	0.37	0.46	0.52	0.59	0.65	0.70						
Sioux City, Iowa	26	9:45 p. m.	11:45 p. m.	0.80	9.49 p. m.	10:05 p. m.	0.01	0.23	0.35	0.44	0.47										
Southeast Farallon, Cal.	18			0.06														0.02			
Spokane, Wash.	10			0.28														0.25			
Springfield, Ill.	29	3:16 p. m.	5:25 p. m.	1.21	3:39 p. m.	3:45 p. m.	0.01	0.43	0.70	0.83											
Springfield, Mo.	13	5:20 p. m.	6:10 p. m.	0.57	5:21 p. m.	5:36 p. m.	T.	0.22	0.41	0.50											
Do.	16	9:50 p. m.	11:25 p. m.	1.10	10:26 p. m.	11:01 p. m.	0.13	0.15	0.20	0.23	0.32	0.53	0.74	0.95							
Do.	22	3:25 p. m.	4:50 p. m.	0.88	3:31 p. m.	3:48 p. m.	T.	0.23	0.50	0.66	0.70										
Do.	25	11:30 a. m.	1:05 p. m.	0.77	12:12 p. m.	12:47 p. m.	0.03	0.22	0.27	0.31	0.53	0.60	0.65	0.71							
Syracuse, N. Y.	17			0.56														0.39			
Tacoma, Wash.	26			0.31														0.12			
Tampa, Fla.	5	7:15 a. m.	10:50 a. m.	1.22	8:55 a. m.	10:00 a. m.	0.01	0.14	0.26	0.29	0.29	0.38	0.64	0.68	0.79	0.81	0.85	0.99	1.18		
Do.	16	4:37 p. m.	8:00 p. m.	1.19	4:41 p. m.	5:11 p. m.	T.	0.32	0.61	0.82	0.94	1.05	1.11								
Do.	29-30	12:24 p. m.	5:40 p. m.	5.75	7:15 p. m.	8:48 p. m.	1.24	0.10	0.21	0.29	0.30	0.39	0.53	0.65	0.78	0.92	1.07	1.28	1.47	1.65	
Tatoosh Island, Wash.	25			0.64														0.23			
Taylor, Tex.	13	6:30 p. m.	7:15 p. m.	0.51	6:44 p. m.	6:54 p. m.	0.01	0.25	0.45												
Thomasville, Ga.	18	12:20 p. m.	1:20 p. m.	1.56	12:26 p. m.	12:59 p. m.	0.02	0.22	0.48	0.91	1.20	1.32	1.43	1.49							
Do.	19	12:55 p. m.	5:40 p. m.	1.81	1:00 p. m.	1:25 p. m.	0.02	0.15	0.49	0.83	1.05	1.14									
Do.	27	2:02 p. m.	5:18 p. m.	4.49	2:17 p. m.	3:18 p. m.	0.01	0.21	0.52	0.64	0.78	1.11	1.68	2.23	2.94	3.38	3.77	4.14	4.26		
Toledo, Ohio	23	1:01 p. m.	2:35 p. m.	0.53	1:07 p m.	1:26 p. m.	0.01	0.08	0.24	0.41	0.47										
Tonopah, Nev.	18			0.12														0.06			
Topeka, Kans.	22	2:58 a. m.	5:30 a. m.	0.93	3:09 a. m.	3:24 a. m.	0.04	0.29	0.50	0.57											
Do.	28	4:00 a. m.	5:40 a. m.	0.91	4:06 a. m.	4:34 a. m.	0.03	0.15	0.20	0.26	0.40	0.52	0.57								
Valentine, Nebr.	8			0.35														0.33			
Vicksburg, Miss.	22	4:45 p. m.	7:10 p. m.	0.96	4:45 p. m.	5:02 p. m.	0.00	0.35	0.63	0.72	0.76										
Walla Walla, Wash.	1			0.26														0.26			
Washington, D. C.	17	5:30 p. m.	6:27 p. m.	0.94	5:49 p. m.	6:24 p. m.	0.04	0.12	0.31	0.45	0.54	0.69	0.78	0.90							
Wichita, Kans.	13	2:26 p. m.	3:37 p. m.	0.80	2:44 p. m.	3:04 p. m.	0.01	0.26	0.50	0.67	0.75										
Do.	16	D. N.	5:15 a. m.	1.18	4:26 a. m.	5:02 a. m.	0.11	0.10	20.0	0.32	0.46	0.58	0.83	1.04	1.06						
Do.	22	6:25 p. m.	9:10 p. m.	1.60	7:15 . pm.	7:53 p. m.	0.41	0.22	0.40	0.43	0.64	0.84	1.05	1.13	1.17						
Williston, N. Dak.	5	8:05 p. m.	9:05 p. m.	0.70	8:12 p. m.	8:22 p. m.	0.02	0.32	0.59												
Do.	12	3:25 p. m.	4:20 p. m.	0.88	3:40 p. m.	3:55 p. m.	0.09	0.31	0.60	0.77											
Do.	20	4:00 a. m.	6:10 a. m.	0.82	4:14 a. m.	4:35 a. m.	0.01	0.10	0.33	0.59	0.71	0.74									
Wilmington, N. C.	14	10:40 p. m.	11:30 p. m.	0.68	10:51 p. m.	11:15 p. m.	0.01	0.14	0.34	0.36	0.39	0.62									
Winnemucca, Nev.	19			0.03														0.01			
Wytheville, Va.	12	4:50 p. m.	8:40 p. m.	2.16	5:11 p. m.	6:28 p. m.	0.18	0.08	0.12	0.18	0.29	9.35	0.60	0.93	1.27	1.55	1.58	1.68	1.91		
Do.	26	2:00 p. m.	2:40 p. m.	0.53	2:07 p. m.	2:27 p. m.	0.01	0.13	0.28	0.45	0.50										
Yankton, S. Dak.	20	3:20 p. m.	10:50 p. m.	2.66	9:10 p. m.	9:59 p. m.	0.85	0.16	0.35	0.60	1.10	1.48	1.63	1.68	1.73						
Do.	23	9:30 a. m.	1:20 p. m.	0.83	10:33 a. m.	11:03 a. m.	0.05	0.08	0.16	0.26	0.35	0.48	0.54								
Yellowstone Park, Wyo.	11			0.31														0.11			

* Self register not working. † Estimated. ‡ No excessive precipitation reported during month.

TABLE III.—*Data furnished by the Canadian Meteorological Service, June, 1909.*

Stations.	Pressure. Actual, reduced to mean of 24 hours.	Pressure. Sea level, reduced to mean of 24 hours.	Pressure. Departure from normal.	Temperature. Mean.	Temperature. Departure from normal.	Temperature. Mean maximum.	Temperature. Mean minimum.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Total snowfall.
	Ins.	Ins.	Ins.	°	°	°	°	Ins.	Ins.	Ins.
St. Johns, N. F.	29.68	29.82	−.09	51.7	+ 0.1	60.8	42.6	3.50	−0.10	1.1
Sydney, C. B. I.	29.88	29.92	−.03	56.6	+ 1.2	68.7	44.6	2.56	−0.67	....
Halifax, N. S.	29.83	29.93	−.02	60.1	+ 2.4	71.8	48.4	1.09	−2.67	....
Grand Manan, N. B.	29.85	29.90	−.03	58.9	+ 2.7	68.2	49.6	1.06	−1.88	....
Yarmouth, N. S.	29.88	29.95	.00	55.3	+ 0.3	63.6	46.9	1.97	−0.79	....
Charlottetown, P. E. I.	29.87	29.91	−.01	59.9	+ 2.5	69.4	50.5	0.73	−1.94	....
Chatham, N. B.	29.84	29.86	−.03	61.5	+ 1.5	73.0	50.0	2.96	−0.50	....
Father Point, Que.	29.82	29.84	−.03	53.2	+ 0.2	62.2	44.1	5.14	+2.16	....
Quebec, Que.	29.56	29.88	−.04	61.7	+ 0.5	73.0	50.4	3.25	−0.40	....
Montreal, Que.	29.70	29.90	−.04	65.9	+ 1.0	74.7	57.1	1.63	−1.90	....
Rockliffe, Ont.	29.32	29.92	−.02	62.1	+ 0.5	77.3	47.0	0.74	−2.42	T.
Ottawa, Ont.	29.67	29.99	−.05	64.0	− 1.3	74.5	53.7	2.37	−0.55	....
Kingston, Ont.	29.66	29.97	.00	62.2	− 1.2	69.6	54.9	1.11	−1.32	....
Toronto, Ont.	29.61	29.98	+.01	65.5	+ 2.1	75.4	55.5	1.20	−1.60	....
White River, Ont.	28.65	29.94	.00	58.8	+ 0.1	73.6	44.0	1.08	−1.14	....
Port Stanley, Ont.	29.37	30.01	+.04	63.4	− 0.4	72.2	54.6	2.87	+0.14	....
Southampton, Ont.	29.31	....	....	62.0	+ 1.6	72.4	51.6	0.70	−1.65	....
Parry Sound, Ont.	29.29	29.97	+.01	64.2	+ 2.5	75.1	53.2	1.10	−1.32	....
Port Arthur, Ont.	29.28	29.99	+.05	59.0	+ 2.6	70.6	47.3	0.57	−2.16	....
Winnipeg, Man.	29.13	29.95	+.06	63.5	+ 1.2	77.1	49.8	1.54	−1.75	....
Minnedosa, Man.	28.17	29.96	+.07	60.7	+ 1.1	73.6	47.8	1.84	−1.16	....
Qu' Appelle, Assin.	27.70	29.92	+.05	58.1	− 1.8	68.4	47.8	2.26	−1.16	....
Medicine Hat, Alberta.	27.68	29.92	+.07	63.0	+ 1.0	74.4	51.6	2.67	−0.09	....
Swift Current, Sask.	27.42	29.95	+.08	60.2	+ 0.2	71.4	49.1	6.46	+3.79	....
Calgary, Alberta.	26.45	29.94	+.09	56.8	+ 0.8	69.5	44.2	2.07	−0.38	....
Banff, Alberta.	25.42	29.96	+.12	52.3	+ 0.8	65.8	38.8	1.81	−1.52	....
Edmonton, Alberta.	27.67	29.93	+.09	58.8	+ 1.9	71.8	45.9	1.85	−1.01	....
Prince Albert, Sask.	28.38	29.92	+.05	57.9	+ 0.2	69.1	46.7	4.34	+1.83	....
Battleford, Sask.	28.22	29.94	+.08	60.8	+ 1.3	72.7	48.9	2.88	−0.43	....
Kamloops, B. C.	28.66	29.90	+.03	66.2	+ 2.4	80.6	51.8	1.02	−0.40	....
Victoria, B. C.	29.96	30.05	+.04	58.0	+ 1.7	67.4	48.5	0.47	−0.73	....
Barkerville, B. C.	25.70	30.00	+.13	48.0	− 2.7	58.7	37.4	1.46	−1.56	....
Hamilton, Bermuda	30.02	30.18	+.06	76.1	+ 1.1	80.0	71.5	1.40	−4.55	....
Dawson, Yukon	....	....	....	....	....	....	....	....	....	....

* Report incomplete.

TABLE IV.—*Heights of rivers referred to zeros of gages, June, 1909.*

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water. Height.	Highest water. Date.	Lowest water. Height.	Lowest water. Date.	Mean stage.	Monthly range.
	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Republican River.								
Clay Center, Kans.	42	18	10.6	25	6.5	8	7.9	4.1
Smoky Hill-Kansas River.								
Abilene, Kans.	254	22	17.8	27, 28	0.7	6, 7	9.1	17.1
Manhattan, Kans.	160	18	9.3	26	4.0	4–7	6.8	5.3
Topeka, Kans.	87	21	11.8	23	7.0	7	9.6	4.8
Missouri River.								
Townsend, Mont.	2,504	11	9.6	7, 8	6.7	30	8.2	2.9
Fort Benton, Mont.	2,285	12	9.7	12	5.7	29	8.1	4.0
Wolfpoint, Mont.	1,952	17	8.0	22	6.1	3	6.9	1.9
Bismarck, N. D.	1,309	14	13.9	15, 26	8.2	1	11.7	5.7
Pierre, S. Dak.	1,114	14	11.4	29	6.3	1	9.4	5.1
Sioux City, Iowa.	784	17	14.7	15	8.9	1	12.5	5.8
Blair, Nebr.	705	15	15.4	18	8.6	1	13.3	6.8
Omaha, Nebr.	669	18	18.5	17	11.3	1	16.2	7.2
Plattsmouth, Nebr.	641	17	11.0	17, 18	5.8	1, 2	9.3	5.2
St. Joseph, Mo.	481	10	13.0	18, 19	5.8	3	10.8	7.2
Kansas City, Mo.	388	21	21.6	25	12.3	1	18.6	9.3
Glasgow, Mo.	231	21	21.6	21	13.6	2	18.8	8.0
Boonville, Mo.	199	20	20.9	20	13.3	3	18.1	7.6
Hermann, Mo.	103	24	18.9	22, 30	11.7	3	16.4	7.2
Minnesota River.								
Mankato, Minn.	127	18	10.5	30	6.9	23	8.1	3.6
St. Croix River.								
Stillwater, Minn.	23	11	9.8	8, 9	7.1	28–30	8.4	2.7
Illinois River.								
La Salle, Ill.	197	18	18.9	10	16.2	3	17.4	2.7
Peoria, Ill.	135	14	14.6	14–16	13.4	4, 5, 24	13.9	1.2
Conemaugh River.								
Johnstown, Pa.	64	7	7.3	11	1.6	1-4, 26, 27	2.5	5.7
Allegheny River.								
Warren, Pa.	177	14	4.0	6, 11	0.9	22, 23	1.7	3.1
Parker, Pa.	73	20	4.6	7	1.5	22, 23	2.5	3.1
Freeport, Pa.	29	20	7.8	12	2.9	24	4.9	4.9
Springdale, Pa.	17	27	12.9	12	9.0	22–24	10.4	3.9
Youghiogheny River.								
Confluence, Pa.	59	10	4.1	6	0.7	22, 26	1.8	3.4
West Newton, Pa.	15	23	6.4	11	1.0	27	2.5	5.4
Monongahela River.								
Fairmont, W. Va.	119	25	18.5	18	14.6	1, 3	15.8	3.9
Greensboro, Pa.	81	18	12.9	18	7.2	1	9.1	5.7
Lock No. 4, Pa.	40	28	15.8	12, 19	8.0	25	11.3	7.8
Muskingum River.								
Zanesville, Ohio.	70	25	14.7	26	8.9	21	11.2	5.8
Little Kanawha River.								
Creston, W. Va.	38	20	6.6	19	2.0	6	2.9	4.6
New-Great Kanawha River.								
Hinton, W. Va.	153	14	4.5	6	2.4	22–25, 27	3.0	2.1
Charleston, W. Va.	58	30	8.9	6	5.4	4	7.2	3.5
Scioto River.								
Columbus, Ohio.	110	17	6.7	11	2.8	1	4.3	3.9
Licking River.								
Falmouth, Ky.	30	25	15.8	11	1.5	8	4.8	14.3
Kentucky River.								
Beattyville, Ky.	254	30	3.7	14	0.4	2, 9	1.4	3.3
Frankfort, Ky.	65	31	10.7	10	6.3	5–9	7.5	4.4
Wabash River.								
Terre Haute, Ind.	171	16	15.0	14, 15	2.9	25	9.3	12.1
Mount Carmel, Ill.	75	15	13.7	9	6.0	26	11.4	7.7
Cumberland River.								
Burnside, Ky.	518	50	12.5	15	4.0	10, 11	7.6	8.5
Celina, Tenn.	383	45	17.5	15	6.4	1	10.7	11.1
Carthage, Tenn.	308	40	13.9	16	5.0	2	8.9	8.9
Nashville, Tenn.	193	40	17.8	23	11.0	3	14.4	6.8
Clarksville, Tenn.	126	43	18.1	24	10.9	4	14.5	7.2
Clinch River.								
Speers Ferry, Va.	156	20	7.2	14	0.4	2	2.8	6.8
Clinton, Tenn.	52	25	14.0	16	4.7	2, 3	9.0	9.3
South Fork, Holston River.								
Bluff City, Tenn.	35	12	3.3	5	1.0	2	1.8	2.3
Holston River.								
Rogersville, Tenn.	103	14	6.2	5	2.5	3	3.6	3.7
French Broad River.								
Asheville, N. C.	144	4	5.9	4	1.4	2	2.6	4.5
Dandridge, Tenn.	46	12	12.0	5	2.5	22	4.1	9.5
Tennessee River.								
Knoxville, Tenn.	635	12	14.0	5	2.5	23	4.5	11.5
Loudon, Tenn.	590	25	14.0	5	2.2	2	5.2	11.8
Kingston, Tenn.	556	25	14.0	5	3.9	2	6.8	10.1
Chattanooga, Tenn.	452	33	25.3	6	6.8	2	11.8	18.5
Bridgeport, Ala.	402	24	19.2	6	5.2	2	9.5	14.0
Guntersville, Ala.	349	31	27.2	7	9.1	2	16.1	18.1
Florence, Ala.	255	16	15.7	8	6.8	3	9.8	8.9
Riverton, Ala.	225	32	32.2	9	18.1	21	22.7	14.1
Johnsonville, Tenn.	95	25	23.0	11	11.5	22	15.8	11.5
Ohio River.								
Pittsburg, Pa.	966	22	10.1	12	4.5	16	6.4	5.6
Coraopolis, Pa.	956	25	10.2	6, 12	6.5	15, 22, 25	8.4	3.7
Beaver Dam, Pa.	937	27	15.1	12	4.6	24	8.7	10.5
Wheeling, W. Va.	875	36	14.0	13	4.2	25	11.8	9.8
Parkersburg, W. Va.	785	36	15.0	9	7.5	25, 26	10.2	7.5
Point Pleasant, W. Va.	703	39	17.9	11	7.3	1, 26	11.2	10.6
Huntington, W. Va.	660	50	23.1	11	11.3	2, 3	15.7	11.8
Cattletsburg, Ky.	651	50	24.0	11	10.2	3	15.4	13.8
Portsmouth, Ohio.	612	50	25.4	11	11.6	3	17.3	13.8
Maysville, Ky.	559	50	25.2	12	11.9	4	17.5	13.3
Cincinnati, Ohio.	499	50	28.8	12	14.0	5	20.1	14.8
Madison, Ind.	413	46	24.3	13	12.9	6	17.8	11.4
Louisville, Ky.	367	28	10.7	13	6.6	6, 7	8.5	4.1
Evansville, Ind.	184	35	22.2	15, 16	11.6	9	16.8	10.6
Mount Vernon, Ind.	148	35	21.8	16	12.3	9, 10	16.6	9.5
Paducah, Ky.	47	43	26.4	16, 17	20.6	29	23.3	5.8
Cairo, Ill.	1	45	37.7	17	32.1	7	34.7	5.6
Neosho River.								
Iola, Kans.	262	10	3.9	25	− 0.4	10	1.0	4.3
Oswego, Kans.	184	20	7.6	15	0.9	12	2.7	6.7
Fort Gibson, Okla.	3	22	16.8	29	10.7	15	12.5	6.1
Canadian River.								
Calvin, Okla.	99	15	4.6	26	1.4	10, 20	2.5	3.2
Black River.								
Blackrock, Ark.	67	12	12.0	18	6.0	16	7.9	6.0
White River.								
Calicorock, Ark.	272	18	11.2	18	2.8	9, 10, 12	4.6	8.4
Batesville, Ark.	217	18	10.8	19	4.4	13	6.5	6.4
Newport, Ark.	185	26	16.8	1	7.0	17	11.2	9.8
Clarendon, Ark.	75	30	24.9	8, 9	20.8	21	23.0	4.1
Arkansas River.								
Wichita, Kans.	832	10	3.8	15, 16	− 2.3	6, 7	0.2	6.1
Tulsa, Okla.	551	16	7.1	1	2.7	12	4.4	4.4
Webbers Falls, Okla.	465	23	15.1	1	7.1	11–13	9.8	8.0
Fort Smith, Ark.	403	22	18.0	1	8.0	27	10.7	10.0
Dardanelle, Ark.	256	21	18.2	1	7.5	29	10.6	10.7
Little Rock, Ark.	176	23	20.6	1	7.2	30	11.0	13.4
Pine Bluff, Ark.	121	25	25.2	1	13.0	16	16.4	12.2
Yazoo River.								
Greenwood, Miss.	175	38	29.6	7–9	23.7	30	27.7	5.9
Yazoo City, Miss.	80	25	25.2	2	22.6	30	24.0	2.6
Ouachita River.								
Camden, Ark.	304	39	26.5	4	7.0	30	15.1	19.5
Monroe, La.	122	40	29.4	15	24.0	1	27.7	5.4
Red River.								
Arthur City, Tex.	688	27	15.3	28	6.2	11	10.0	9.1
Fulton, Ark.	515	28	20.6	21	8.4	12	14.7	12.2
Shreveport, La.	327	29	10.2	23	2.4	15	6.5	7.8
Alexandria, La.	118	36	22.3	4	11.6	18	16.3	10.7

TABLE IV.—*Heights of rivers referred to zeros of gages*—Continued.

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Fort Ripley, Minn.	2,082	10	6.4	3,4	4.6	28,30	5.3	1.8
St. Paul, Minn.	1,954	14	8.8	8	6.9	1	7.8	1.9
Red Wing, Minn.	1,914	14	7.2	10,11	4.6	30	5.9	2.6
Reeds Landing, Minn.	1,884	12	7.0	11	4.6	29,30	5.7	2.4
La Crosse, Wis.	1,819	12	8.1	14	5.9	30	7.1	202
Prairie du Chien, Wis	1,759	18	9.5	17	7.0	30	8.4	2.5
Dubuque, Iowa	1,699	18	10.5	1	8.0	30	9.4	2.5
Clinton, Iowa	1,629	16	10.2	1	8.1	30	9.3	2.1
Leclaire, Iowa	1,609	10	6.2	10,11	4.8	30	5.5	1.4
Davenport, Iowa	1,593	15	9.6	11	7.4	30	8.4	2.2
Muscatine, Iowa	1,562	16	11.1	11,12	8.8	8	9.9	2.3
Galland, Iowa	1,472	8	6.2	12,13	4.6	25,26	5.3	1.6
Keokuk, Iowa	1,463	15	12.6	12	8.8	25	10.5	3.8
Warsaw, Ill.	1,458	18	16.0	11	11.8	25	13.7	4.2
Hannibal, Mo.	1,402	13	14.4	12,13	10.0	26	12.0	4.4
Grafton, Ill.	1,308	23	17.3	15	13.7	30	15.5	3.6
St. Louis, Mo.	1,264	30	26.2	14	20.2	5,8	23.8	6.0
Chester, Ill.	1,189	30	22.6	15,21-23	17.6	9	20.6	5.0
Cape Girardeau, Mo.	1,128	28	27.4	22,23	22.4	10	25.3	5.0
New Madrid, Mo.	1,003	34	30.8	17,18	26.6	7	28.6	4.2
Memphis, Tenn.	843	33	29.5	21,22	25.3	10	27.3	4.2
Helena, Ark.	767	42	37.2	22-24	32.9	1	34.9	4.3
Arkansas City, Ark.	635	47	42.6	4-7	39.8	17	41.3	2.8
Greenville, Miss.	595	42	36.3	5-7	33.6	17-19	35.0	2.7
Vicksburg, Miss.	474	45	43.2	1-3	40.2	21-23,30	41.5	3.0
Natchez, Miss.	373	46	45.2	3,4	41.8	30	43.4	3.4
Baton Rouge, La.	240	35	34.1	4,5	31.4	30	32.9	2.7
Donaldsonville, La	188	28	26.9	3-5	24.6	30	25.9	2.3
New Orleans, La.	108	18	17.0	3	15.7	23-26,30	16.3	1.3
Atchafalaya River.								
Simmesport, La.	127	41	38.7	6-8	36.0	30	37.6	2.7
Melville, La.	103	37	35.3	6-8	33.6	30	34.6	1.7
Morgan City, La.	19	8	4.7	1	3.5	8	4.0	1.2
Hudson River.								
Troy, N. Y.	154	14	4.9	4	2.9	25	3.7	2.0
Albany, N. Y.	147	12	5.6	7	1.3	28	3.7	4.3
Delaware River.								
Hancock (E. Branch), N.Y.	287	12	4.1	19	3.1	29,30	3.5	1.0
Hancock (W. Branch), N.Y.	287	10	5.9	18	3.1	4	4.0	2.8
Port Jervis, N. Y.	215	14	4.8	19	2.0	4	3.3	2.8
Phillipsburg, N. J.	146	26	3.9	19,20	1.6	30	2.5	2.3
Trenton, N. J.	92	18	2.8	19	1.4	30	2.0	1.4
N. Br. Susquehanna River.								
Binghamton, N. Y.	183	14	3.9	11	2.3	30	3.0	1.6
Wilkesbarre, Pa.	60	17	8.9	12	4.0	4,5	5.7	4.9
W. Br. Susquehanna River.								
Williamsport, Pa.	39	20	6.4	15	2.1	4	3.6	4.3
Susquehanna River.								
Harrisburg, Pa.	69	17	4.7	17	2.3	5	3.4	2.4
Shenandoah River.								
Riverton, Va.	58	22	2.1	6,10	−0.5	2-4,28-30	0.3	2.6
Potomac River.								
Cumberland, Md.	290	8	5.7	2	2.8	22-26	3.7	2.9
Harpers Ferry, W. Va.	172	18	5.0	12	1.0	3	3.4	4.0
James River.								
Lynchburg, Va.	260	20	4.8	4	1.4	24-26	2.5	3.4
Columbia, Va.	167	18	10.6	5	4.4	28	6.7	6.2
Richmond, Va.	111	10	3.7	6	0.4	27	1.4	3.3
Dan River.								
Danville, Va.	55	8	7.3	5	0.4	3,9-11	1.2	6.9
Roanoke River.								
Clarksville, Va.	106	12	8.0	6	0.6	24	2.2	7.4
Weldon, N. C.	129	30	34.4	7	11.1	25	16.8	23.3
Tar River.								
Greenville, N. C.	21	22	13.6	10	4.5	3	10.2	9.1
Haw River.								
Moncure, N. C.	171	25	19.5	5	7.0	2,3	9.4	12.5
Cape Fear River.								
Fayetteville, N. C.	112	38	32.8	6	4.8	3	11.3	28.0
Pedee River.								
Cheraw, S. C.	140	27	31.4	6	4.0	26	13.1	27.4
Smiths Mills, S. C.	51	16	15.8	17,18	11.3	11	13.0	4.5
Lynch Creek.								
Effingham, S. C.	35	12	12.2	13	3.8	30	7.0	8.4
Black River.								
Kingstree, S. C.	45	12	8.0	26	1.0	12	4.0	7.0
Catawba-Wateree River.								
Mount Holly, N. C.	143	15	10.0	5	2.0	1-3, 22-26, 29, 30	3.2	8.0
Catawba-Wateree River—Con.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Catawba, S. C.	107	11	16.1	5	3.3	3	6.4	12.8
Camden, S. C.	37	24	31.7	5	10.2	2	17.6	21.5
Congaree River.								
Columbia, S. C.	52	15	22.0	5	3.0	1, 2, 10, 13, 27	6.4	19.0
Santee River.								
Ferguson, S. C.	82	12	15.6	10	12.7	4	13.5	2.9
Savannah River.								
Calhoun Falls, S. C.	347	15	11.7	4	3.0	2,30	4.6	8.7
Augusta, Ga.	268	32	28.7	5	10.5	1,22	14.0	18.2
Oconee River.								
Dublin, Ga.	79	30	8.8	9	1.9	13,14	4.0	6.9
Ocmulgee River.								
Macon, Ga.	134	18	13.0	4	4.0	12,13,29,30	5.8	9.0
Abbeville, Ga.	51	11	8.9	11	3.9	17	6.0	5.0
Flint River.								
Montezuma, Ga.	152	20	9.6	7	4.0	14	5.5	5.6
Albany, Ga.	99	20	4.9	9	1.4	18	3.0	3.5
Bainbridge, Ga.	22	22	8.3	10	5.2	17,18	6.6	3.1
Chattahoochee River.								
Oakdale, Ga.	305	21	16.7	5	7.1	10	9.3	9.6
Westpoint, Ga.	174	20	8.6	4,6	4.0	13,14	5.1	4.6
Eufaula, Ala.	90	40	20.0	5	4.8	14	8.2	15.2
Alaga, Ala.	30	30	19.2	6	6.8	14	9.5	12.4
Coosa River.								
Rome, Ga.	266	30	21.0	5	3.2	21	8.1	17.8
Gadsden, Ala.	162	22	19.9	7	4.7	1	10.3	15.2
Lock No. 4, Ala.	113	17	15.5	6	4.1	1	8.6	11.4
Wetumpka, Ala.	12	45	31.0	7	10.2	20	17.8	20.8
Alabama River.								
Montgomery, Ala.	323	35	30.0	7	7.9	20	15.5	22.1
Selma, Ala.	246	35	34.3	8	11.0	21	20.0	23.3
Black Warrior River.								
Tuscaloosa, Ala.	90	43	51.6	5	11.6	21	26.5	4.00
Tombigbee River.								
Columbus, Miss.	316	33	20.5	4	2.5	21	9.9	18.0
Demopolis, Ala.	168	35	51.1	11	25.1	22	42.4	26.0
Pascagoula River.								
Merrill, Miss.	78	20	25.1	4	9.8	20	18.7	15.3
Pearl River.								
Columbia, Miss.	110	18	27.6	5	11.2	28	20.0	16.4
Sabine River.								
Logansport, La.	315	25	7.3	3	1.4	21,29,30	3.2	5.9
Neches River.								
Beaumont, Tex.	18	10	3.2	3,4	0.7	20	2.0	2.5
Trinity River.								
Dallas, Tex.	320	25	19.7	25	3.1	3,9	9.1	16.6
Long Lake, Tex.	211	40	13.7	30	2.7	13	6.8	11.0
Liberty, Tex.	20	25	16.3	3,4	4.6	19	8.3	11.7
Brazos River.								
Waco, Tex.	285	24	15.1	18	1.6	13,14	5.5	13.5
Hempstead, Tex.	140	40	16.0	20	0.3	2	6.7	15.7
Booth, Tex.	61	39	15.5	21	4.3	14-16	7.4	11.2
Colorado River.								
Austin, Tex.	214	18	10.6	4	2.1	16,17	3.7	8.5
Columbus, Tex.	98	24	20.9	5	6.7	19	10.1	14.2
Rio Grande River.								
San Marcial, N. Mex.	1,233	14	12.7	11-14	10.9	30	11.8	1.8
El Paso, Tex.	1,030	14	14.3	16	12.5	9	13.4	1.8
Red River of the North.								
Moorhead, Minn.	284	26	12.0	3,4	9.2	27	10.4	2.8
Snake River.								
Lewiston, Idaho	144	24	19.0	5	11.7	30	14.9	7.3
Riparia, Wash.	67	30	17.8	6	10.8	30	14.2	7.0
Columbia River.								
Wenatchee, Wash.	473	40	39.7	23,24	24.0	1	36.0	15.7
Umatilla, Oreg.	270	25	22.6	18	15.8	1	20.8	6.8
The Dalles, Oreg.	166	40	38.2	19	24.6	1,2	34.2	13.6
Willamette River.								
Albany, Oreg.	118	20	5.3	1-3	2.0	29,30	3.2	3.3
Portland, Oreg.	12	15	21.6	21	13.8	1	19.3	7.8
Sacramento River.								
Red Bluff, Cal.	265	23	4.1	3	2.4	30	3.1	1.7
Colusa, Cal.	156	28	9.2	5	5.6	30	7.4	3.6
Knights Landing, Cal.	99	18	11.5	5,6	7.6	30	9.9	3.9
Sacramento, Cal.	64	25	18.4	4-6	13.2	30	16.3	5.2
San Joaquin River.								
Pollasky, Cal.	203	10	7.6	5,6	4.0	20	5.8	3.6
Firebaugh, Cal.	148	14	12.5	15	9.2	1	11.7	3.3
Lathrop, Cal.	49	14	17.9	7	15.6	1	16.9	2.3

Honolulu, T. H., latitude 21° 19′ north, longitude 157° 52′ west; barometer above sea, 38 feet; gravity correction, −0.957 inch, applied. June, 1909.

Day.	Pressure, in inches.*		Air temperature, degrees Fahrenheit.				Moisture.				Wind, in miles per hour.				Precipitation, inches.		Clouds.					
							a. m.		8 p. m.		8 a. m.		8 p. m.				8 a. m.			8 p. m.		
	8 a. m.	8 p. m.	8 a. m.	8 p. m.	Maximum.	Minimum.	Wet.	Relative humidity.	Wet.	Relative humidity.	Direction.	Velocity.	Direction.	Velocity.	8 a. m.	8 p. m.	Amount.	Kind.	Direction, from.	Amount.	Kind.	Direction, from.
							°	%	°	%												
1	30.06	30.07	76.0	74.0	81	69	68.0	66	67.0	69	se.	6	ne.	12	0.00	0.00	8 Few	A.-cu. Cu.	sw. e.	4 4	A.-s. A.-cu.	n. nw.
2	30.10	30.06	78.0	73.5	82	70	68.1	60	67.0	71	ne.	6	ne.	15	0.00	0.00	1 Few	Ci.-cu. Cu.	s. e.	3 4	A.-s. Cu.	n. e.
3	30.07	30.02	74.4	74.5	80	70	68.0	70	68.0	72	ne.	11	ne.	6	0.00	0.00	2	Cu.	e.	Few 1	S.-Cu. Cu.	ne. ne.
4	30.03	30.02	74.0	75.0	81	69	70.0	82	68.0	70	se.	2	ne.	4	0.03	T.	9	S.cu.	e.	3 1	Cu. Cu.n.	ne. ne.
5	30.03	30.02	75.0	74.5	80	70	68.0	70	67.5	70	e.	6	n.	4	T.	0.00	9	S.cu.	e.	0	0	0
6	30.04	30.02	77.2	72.5	82	69	69.0	66	69.0	84	e.	5	e.	9	0.01	0.08	8 1	Ci.-s. Cu.	w. e.	10	N.	ne.
7	30.03	30.02	77.2	74.5	82	73	68.5	64	69.0	76	e.	5	e.	6	T.	T.	6 3	A.-s. A.-cu.	0 e.	10	N.	ne.
8	30.03	30.04	78.0	75.0	80	73	68.0	60	69.0	74	ne.	9	e.	6	T.	T.	9 Few	A.cu. Cu.-n.	0 0	10	Cu.	ne.
9	30.05	30.04	77.0	76.0	82	74	67.0	59	67.0	62	e.	12	e.	15	T.	0.00	9 1	A.-s. Cu.	0 e.	6	S.	e.
10	30.08	30.08	75.1	74.0	79	69	67.2	66	67.5	71	e.	13	e.	12	T.	0.00	10	S.-cu.	e.	6	Cu.	ne.
11	30.11	30.08	77.4	75.0	80	72	67.0	58	67.0	66	e.	12	ne.	6	0.01	0.00	2 4	Ci.-cu. Cu.	sw. e.	1	A.-s.	0 (?)
12	30.10	30.08	75.1	73.5	80	68	66.0	62	68.0	76	ne.	11	e.	10	0.03	0.00	9	A.-cu.	e.	7	S.	e.
13	30.09	30.11	77.0	74.0	81	70	67.2	60	67.0	69	e.	11	e.	10	T.	0.02	4 3	Ci.-s. Cu.	w. e.	8	A.-s.	nw.
14	30.12	30.10	72.0	73.0	80	69	67.0	77	67.0	73	n.	7	ne.	10	0.06	0.00	3 6	A.-cu. S.-cu.	e. e.	Few Few	Cu. S.-cu.	ne. ne.
15	30.12	30.11	77.0	76.0	82	70	68.0	63	67.0	62	ne.	10	ne.	14	T.	0.00	2	Cu.	e.	Few 2	S.-cu. Cu.	ne. ne.
16	30.16	30.14	77.1	75.0	82	72	68.0	67	69.5	76	ne.	10	e.	12	T.	T.	3	Cu.	e.	5	S.	ne.
17	30.14	30.13	75.7	75.0	81	71	68.0	67	68.0	70	ne.	7	ne.	12	0.01	0.00	10	S.-cu.	e.	3	Cu.	ne.
18	30.11	30.09	75.0	76.0	81	70	67.5	64	68.0	66	ne.	11	ne.	4	0.09	0.00	5	Cu.	e.	7	S.	ne.
19	30.06	30.03	73.5	73.5	78	70	69.1	81	69.0	80	ne.	4	e.	15	0.02	0.16	10	A.-s.	e.	8	S.	ne.
20	30.05	30.05	75.3	73.5	78	71	70.0	77	69.0	80	e.	14	e.	10	0.04	0.02	7	A.-cu.	e.	6	S.	ne.
21	30.05	30.06	77.8	74.0	82	72	70.0	68	68.0	74	ne.	7	ne.	10	T.	T.	2	Cu.	e.	3	Cu.	ne.
22	30.11	30.09	78.0	76.0	82	74	69.0	63	69.0	70	e.	9	e.	7	T.	0.00	2	Cu.	e.	5	Cu.	ne.
23	30.09	30.07	75.0	74.0	83	72	69.2	75	69.0	78	ne.	9	ne.	12	0.01	T.	3	Cu.	e.	3 2	Cu. N.	ne. ne.
24	30.07	30.03	77.1	75.0	82	72	67.1	59	66.5	64	ne.	4	e.	8	0.01	0.00	4	Cu.	e.	2	Cu.	ne.
25	30.01	29.97	77.2	73.7	79	70	68.0	63	69.0	79	e.	5	ne.	10	T.	0.03	3	Cu.	e.	7	Cu.	ne.
26	30.01	30.00	77.1	75.0	82	71	68.1	63	68.0	70	e.	8	ne.	8	0.01	T.	4	Cu.	e.	4	Cu.	ne.
27	30.05	30.01	76.3	75.0	81	70	69.0	69	68.0	70	ne.	3	e.	12	0.02	T.	3 5	Ci. Cu.	0? e.	4 6	Ci.-s. Cu.	0 ne.
28	30.02	30.02	76.0	76.0	81	72	67.1	62	67.0	62	e.	9	e.	13	T.	0.00	1 4	Ci.-s. Cu.	0 e.	3	Cu.	ne.
29	30.04	30.01	76.2	75.5	81	73	68.0	65	70.0	76	e.	12	ne.	12	T.	.000	10	Cu.	e.	7 3	Ci.-s. Cu.	n. e.
30	30.02	30.02	77.2	74.5	79	71	68.0	62	67.5	70	ne.	17	se.	8	00.1	0.00	5 2	A.-cu. S.-cu.	e. e.	3	Cu.	ne.
31																						
Mean	30.068	30.053	76.2	74.6	80.8	70.9	68.1	66.3	68.0	71.6	ne.	8.5	ne, e.	9.7	0.36	0.31	6.4	Cu.	e.	5.4	Cu.	ne.

Observations are made at 8 a. m. and 8 p. m. local standard time, which is that of 157. 30′ west, and is 5h and 30m slower than 75th meridian time. * Pressure values arereduced to sea level and standard gravity.

DESCRIPTION OF TABLES AND CHARTS.

By Mr. P. C. Day, Acting Chief, Climatological Division.

For description of tables and charts see page 34 of Review for January, 1909.

Chart I. Hydrographs for Seven Principal Rivers of the United States, June, 1909.

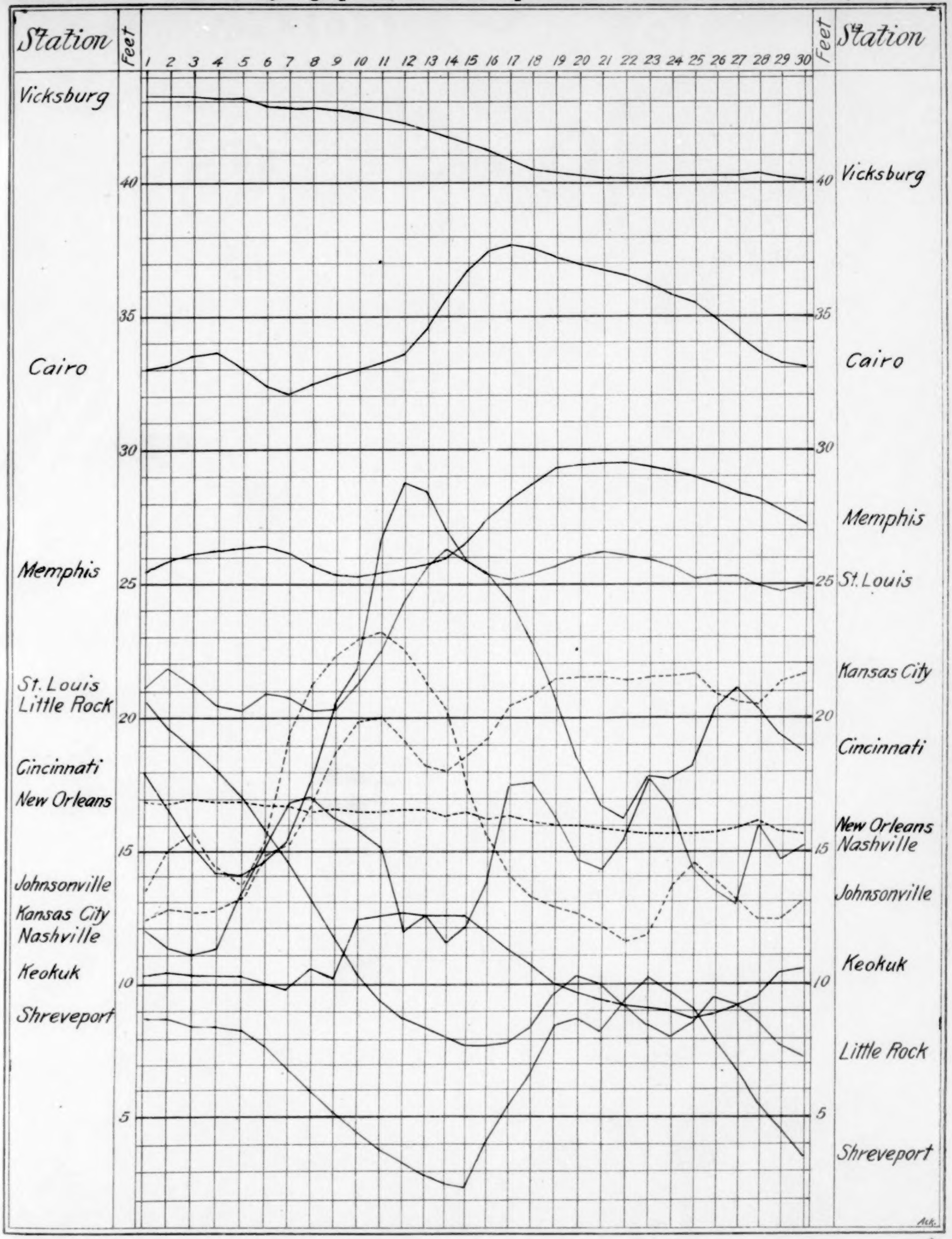


Chart II. Tracks of Centers of High Areas, June, 1909.

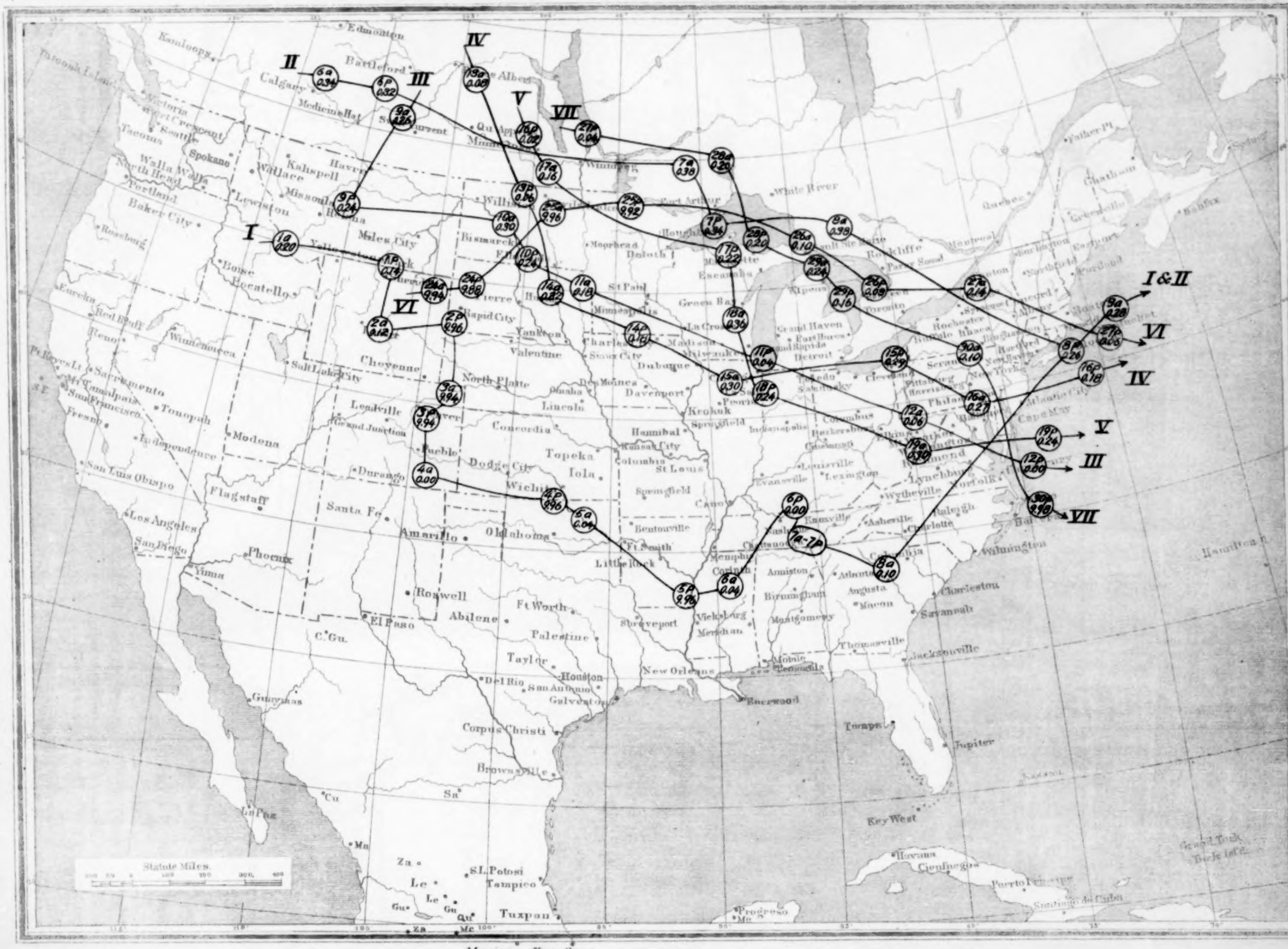


Chart III. Tracks of Centers of Low Areas, June, 1909.

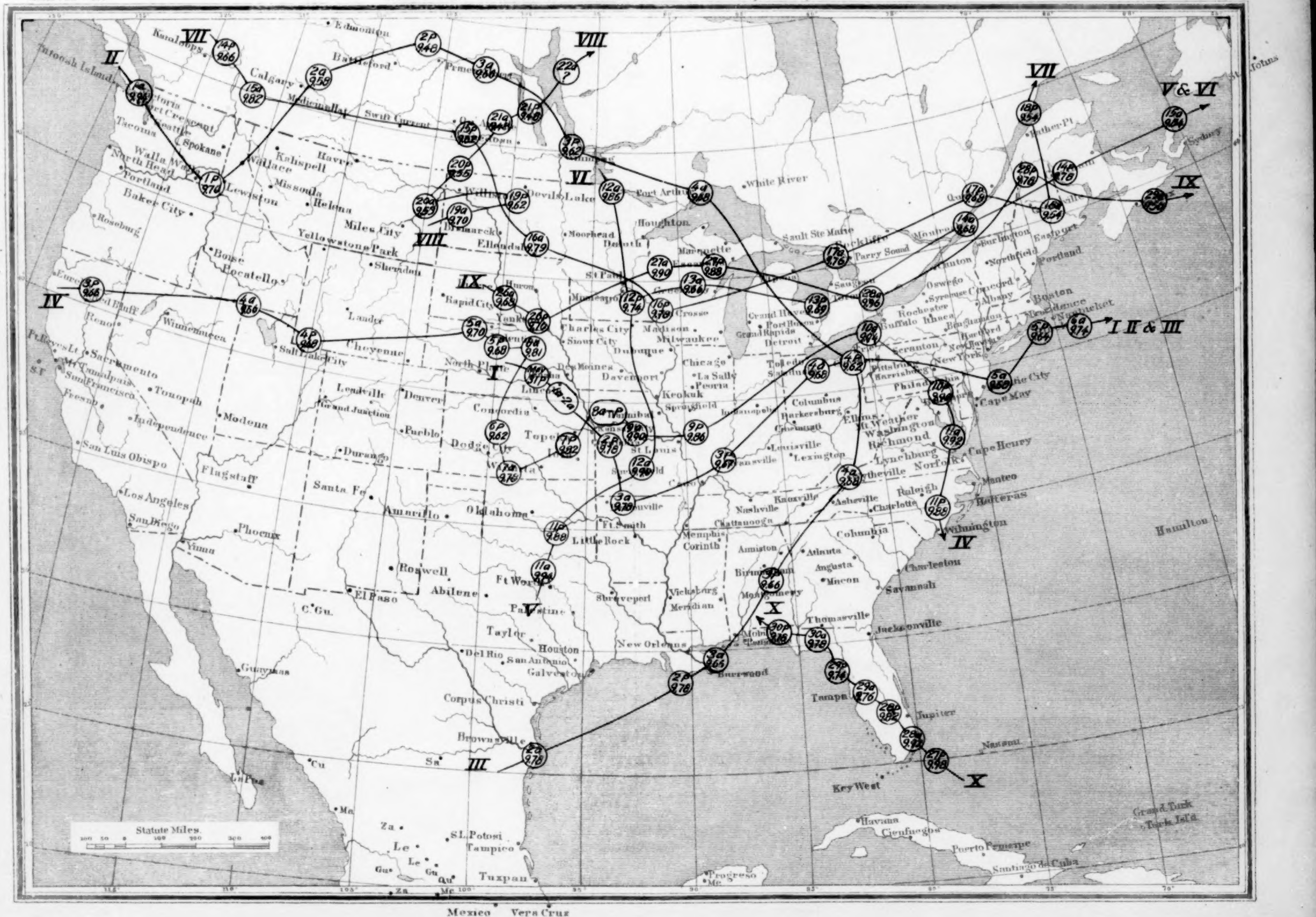
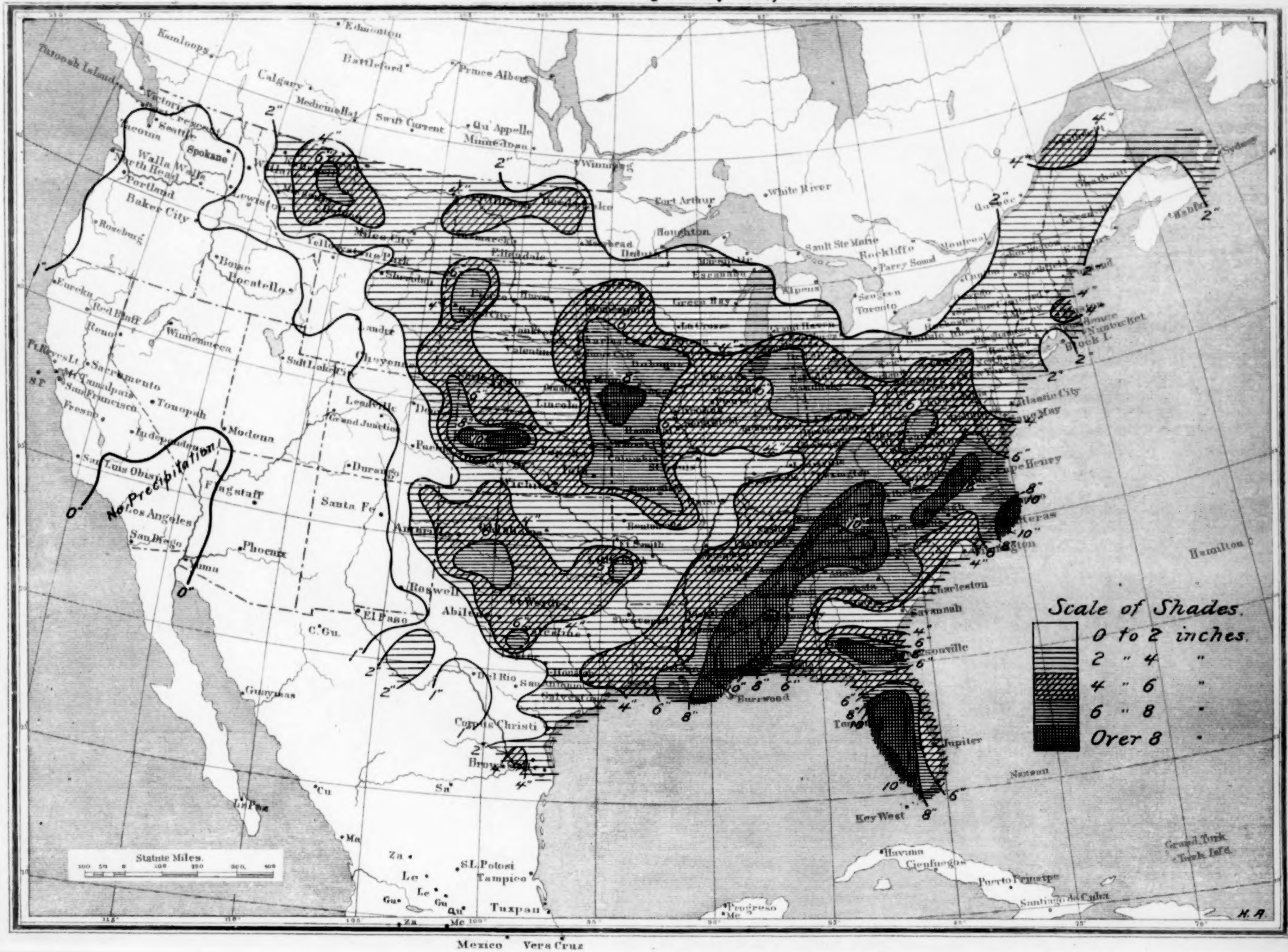


Chart IV. Total Precipitation, June, 1909.



XXXVII—49. Chart V. Percentage of Clear Sky between Sunrise and Sunset

Chart V. Percentage of Clear Sky between Sunrise and Sunset, June, 1909.

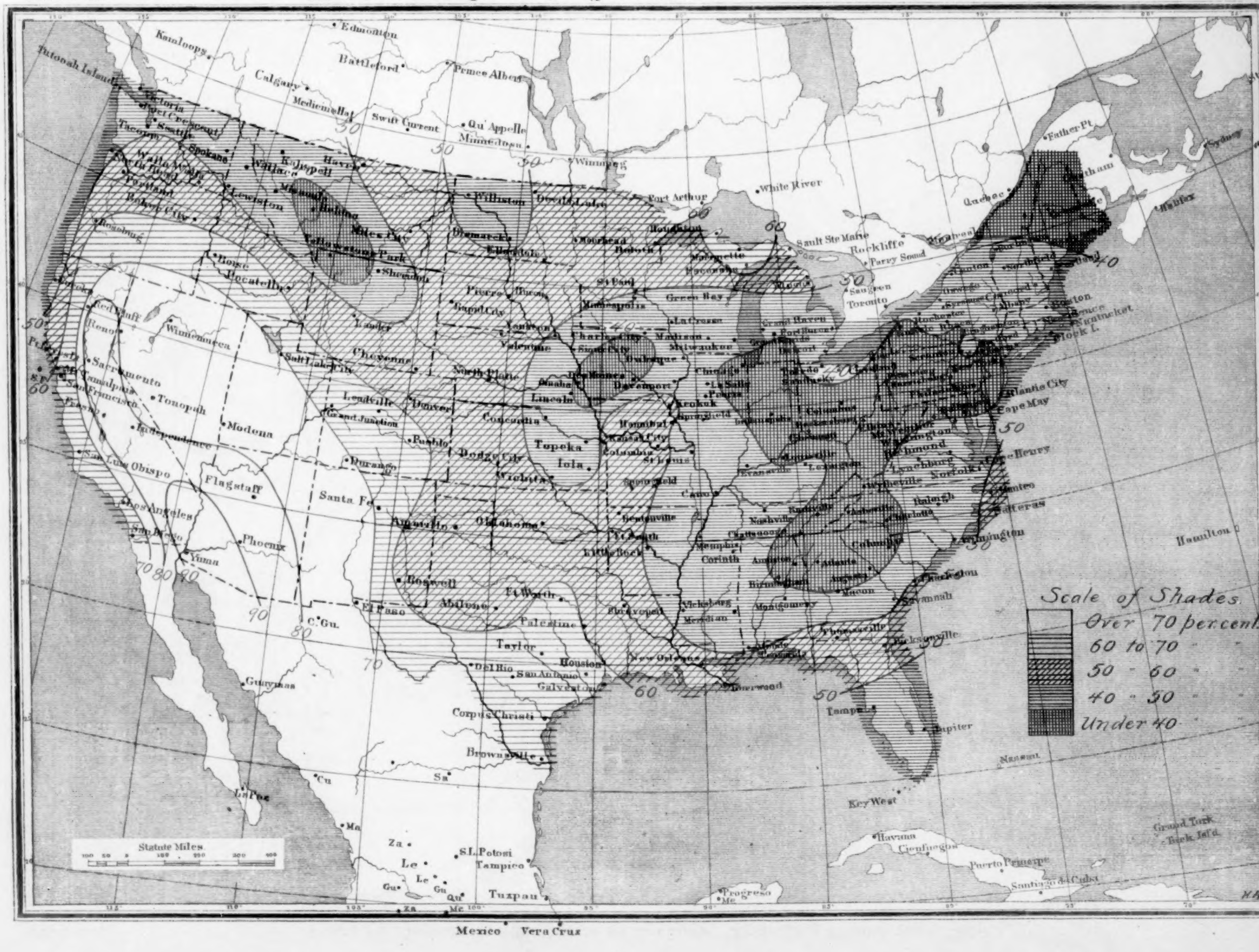


Chart VI. Isobars and Isotherms at Sea Level; Prevailing Winds, June, 1909.